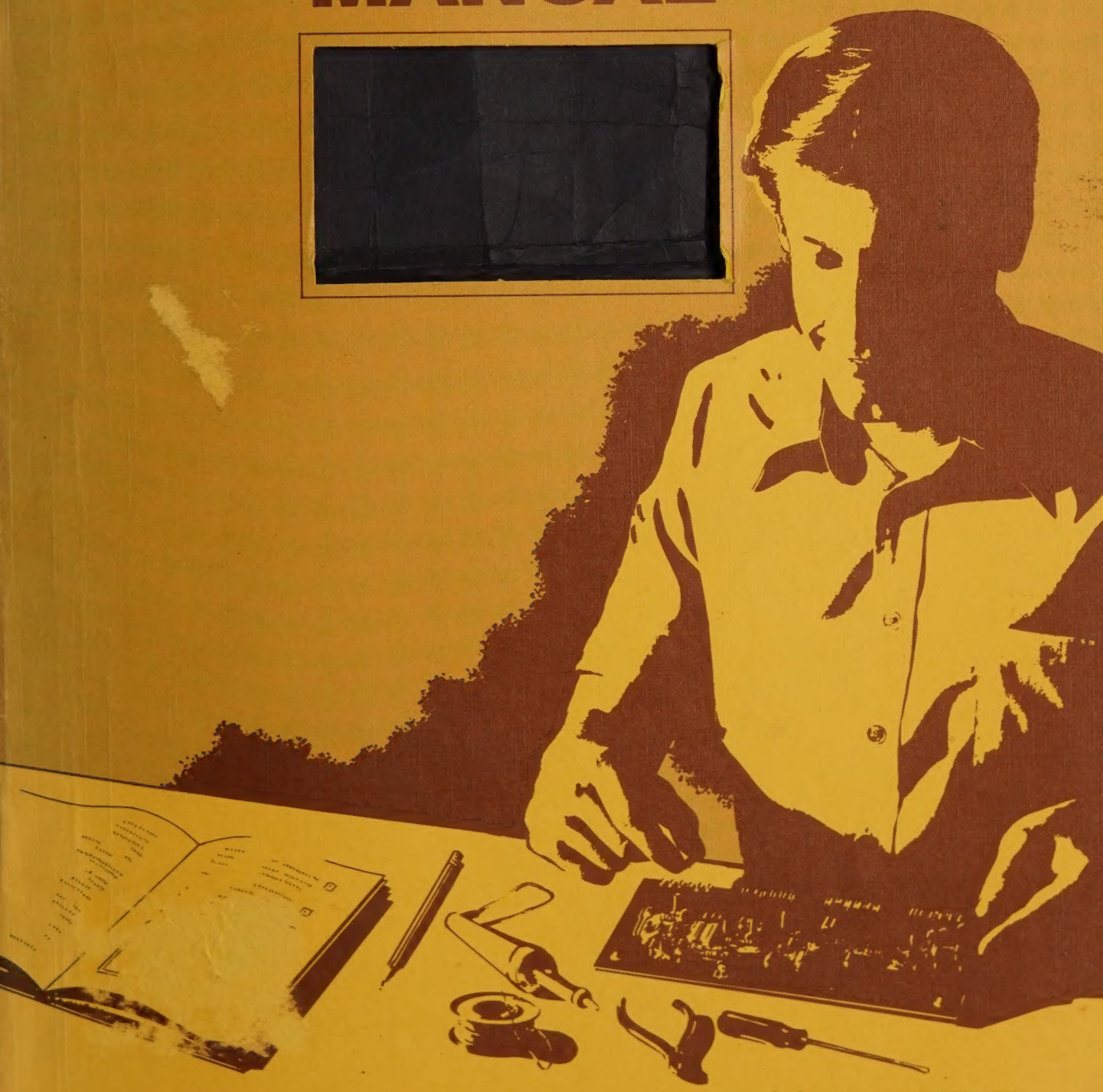
HEATHKIT® MANUAL



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 4:30 P.M., EST, Weekdays Only

Audio,	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Weather Instruments and Home Clocks	(616) 982-3315
Television	(616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products	(616) 982-3496
Computers — Hardware	(616) 982-3309
Computers — Software:	
Operating Systems, Languages, Utilities	(616) 982-3860
Application Programs	(616) 982-3884

YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heath/Zenith Computers and Electronics center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORESEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

Heathkit® Manual

for the

DIGITAL DESIGN EXPERIMENTER

Model ET-3200B

595-2936-06

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Model ET-3200B Digital Design Experimenter is compact and self-contained so you can quickly design and experiment with digital electronic circuits. The Experimenter has the following built-in features:

- Three power supplies — to power both digital and linear circuits.
- Four logic Data switches.
- Two "no bounce" logic switches.
- A 3-frequency pulse generator (clock).
- Four LED logic-state indicators.
- Internal circuitry compatible with most of today's commonly used logic families.
- Connector blocks for "solderless" connections between parts and wires.

The ET-3200B is also an excellent learning tool and is a recommended supplement to the individual learning programs of Heathkit Continuing Education.

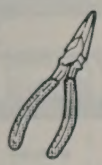
Most of the components are mounted on the circuit board. This makes the kit easy to assemble. The compact size and light weight allow you to move or place the Experimenter almost anywhere.

ASSEMBLY NOTES

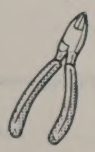
TOOLS

You will need these tools to assemble your kit.

PLIERS

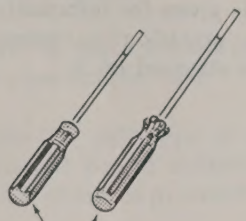


LONG-NOSE PLIERS



DIAGONAL CUTTERS

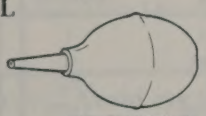
WIRE STRIPPERS



1/8" & 1/4"-BLADE SCREWDRIVERS

PHILLIPS SCREWDRIVER

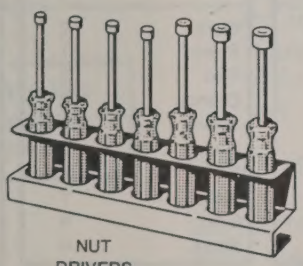
OTHER HELPFUL TOOLS



DESOLDERING BULB*

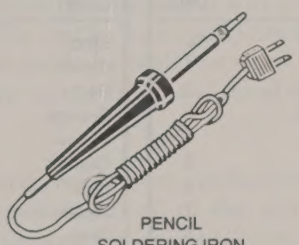
NUT STARTER (May Be Supplied With Kit)

DESOLDERING BRAID*



NUT DRIVERS

*To Remove Solder From Circuit Connections.



PENCIL SOLDERING IRON (22 to 25 WATTS)

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

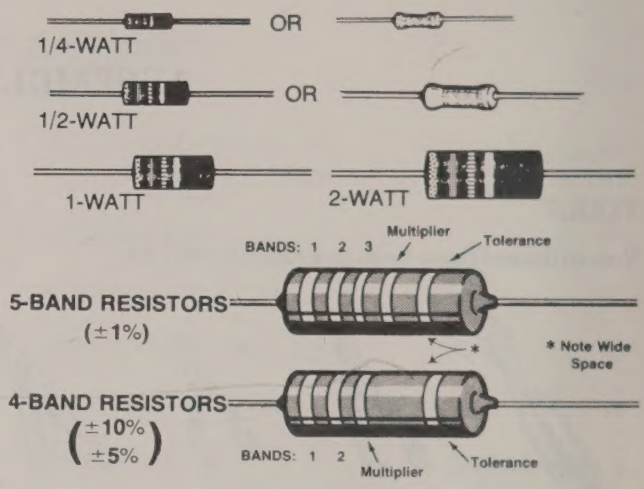
3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder a part or a group of parts only when you are instructed to do so.

PARTS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.



Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

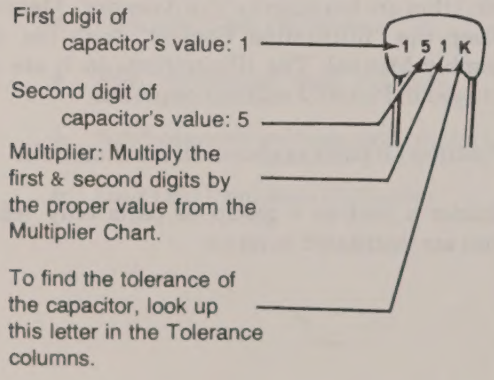
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	±10%
Gold	± 5%
Brown	± 1%

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:


First digit of capacitor's value: 1
Second digit of capacitor's value: 5
Multiplier: Multiply the first & second digits by the proper value from the Multiplier Chart.
To find the tolerance of the capacitor, look up this letter in the Tolerance columns.
1 5 1 K

EXAMPLES:

151K = 15 × 10 = 150 pF
759 = 75 ×0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point: as in: 2R2 = 2.2 (pF or μF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	±0.1 pF	B	
1	10	±0.25 pF	C	
2	100	±0.5 pF	D	
3	1000	±1.0 pF	F	±1%
4	10,000	±2.0 pF	G	±2%
5	100,000		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

*DuPont Registered Trademark

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In the Schematic,

   — In the section at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

SAFETY WARNING: Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

It is easy to make a good solder connection if you follow a few simple rules:

1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8″ or 3/16″ chisel or pyramid tip works best.

2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers on the Parts Pictorial Illustration Booklet Page 1. Any part that is packed in an individual envelope with the part number on it should be placed back in the envelope after you identify it until it is called for in a step. Do not throw away any packing materials until all parts are accounted for.

To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual. For pricing information, refer to the separate "Heath Parts Price List."

Each circuit part in this kit has its own component number (R2, C4, etc.). Use these numbers when you want to positively identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

- In the Parts List,
- At the beginning of each step where a component is installed,
- In some illustrations,
- In the Schematic,
- In the sections at the rear of the Manual.

RESISTORS, 1/4-Watt

Composition

NOTES:

1. The following resistors have a 5% tolerance (gold fourth band).
2. The resistors may be packed in more than one envelope. Open all the resistor envelopes before you check the resistors against the Parts List.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-479-12	2	4.7 Ω (yellow-violet-gold)	R4, R14
A1	6-151-12	4	150 Ω (brown-green-brown)	R23, R26, R32, R37
A1	6-221-12	1	220 Ω (red-red-brown)	R5
A1	6-471-12	1	470 Ω (yellow-violet-brown)	R39
A1	6-511-12	2	510 Ω (green-brown-brown)	R2, R12
A1	6-821	1	820 Ω, 1/2-watt (gray-red-brown)	R1
A1	6-102-12	8	1000 Ω (brown-black-red)	R3, R13, R44, R45, R28, R31, R34, R36
A1	6-272-12	1	2700 Ω (red-violet-red)	R7
A1	6-472-12	5	4700 Ω (yellow-violet-red)	R22, R25, R29, R35, R43
A1	6-103-12	2	10 kΩ (brown-black-orange)	R41, R42
A1	6-153-12	1	15 kΩ (brown-green-orange)	R46

Resistors (cont'd.)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-683-12	1	68 kΩ (blue-gray-orange)	R47
A1	6-104-12	4	100 kΩ (brown-black-yellow)	R21, R24, R27, R33
A1	6-154-12	4	150 kΩ (brown-green-yellow)	R48, R49, R51, R52

1% Precision

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-2001-12	1	2000 Ω (red-black-black-brown)	R17
A1	6-2251-12	1	2250 Ω (red-red-green-brown)	R18

CAPACITORS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
B1	20-109	1	62 pF mica	C11
B2	21-163	2	.001 µF disc (small)	C4, C7
B2	21-71	2	.001 µF disc (large)	C102, C103
B3	27-44	1	.01 µF Mylar*	C10
B3	27-127	1	.047 µF Mylar	C101
B4	25-220	1	10 µF tantalum	C9
B5	25-865	3	10 µF electrolytic	C3, C5, C8
B6	25-876	2	1000 µF electrolytic	C1, C6
B6	25-877	1	2200 µF electrolytic	C2

*DuPont Registered Trademark

DIODES — LED's

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C1	56-56	1	1N4149	D9
C1	56-97	1	1N3017	ZD1
C1	57-65	8	1N4002	D1, D2, D3, D4, D5, D6, D7, D8
C2	412-640	5	LED	L1, L2, L3 L4, D11

TRANSISTORS-INTEGRATED CIRCUITS

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D1	417-235	3	2N4121 transistor	Q5, Q7, Q8
D1	417-801	12	MPSA20 transistor	Q1, Q3, Q4, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17
D2	417-818	1	MJE181 transistor	Q2
D2	417-819	1	MJE171 transistor	Q6
D3	442-53	1	NE555V integrated circuit	IC3
D4	442-54	1	μA7805 integrated circuit	IC1
D5	443-54	2	SN7403N integrated circuit	IC2, IC4

COIL-CONTROL-SWITCHES-INSULATORS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
E1	45-615	1	Toroid coil	L101
E2	10-382	1	2000 Ω (2K) control	R6
E3	60-22	1	DPTT slide switch	SW7
E4	60-78	4	DPDT slide switch	SW1, SW2, SW3, SW4,
E5	60-86	2	SPDT slide switch (spring return)	SW5, SW6
E6	60-607	1	SPST rocker switch	SW101
E7	73-92	5"	Foam tape	
E8	75-724	1	Insulator plate	
E9	75-52	1	Switch insulator	
E10	75-29	1	Strain relief	
E11	75-809	1	Insulator paper	

HARDWARE

NOTE: The hardware may be in more than one packet. Open all the hardware packets before you check the hardware against the Parts List.

#4 Hardware

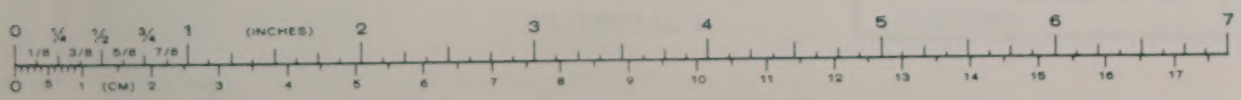
KEY No.	HEATH Part No.	QTY.	DESCRIPTION
F1	250-1412	2	4-40 × 3/8" black phillips head screw
F2	250-163	3	#4 × 5/16" self-tapping screw
F3	252-2	2	4-40 nut
F4	254-9	2	#4 lockwasher

#6 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
F5	250-1325	4	6-32 × 1/4" black phillips head screw
F6	250-1280	1	6-32 × 3/8" black phillips head screw
F7	250-1420	1	6-32 × 3/8" black flat phillips head screw
F8	250-1434	9	#6 × 3/8" black self-tapping phillips head screw
F9	250-1435	1	#6 × 1/2" black self-tapping phillips head screw
F10	250-1460	8	#6 × 5/8" black self-tapping flat phillips head screw
F11	250-1137	2	#6 × 1-1/8" self-tapping screw
F12	252-3	2	6-32 nut
F13	252-170	2	6-32 brass insert nut
F14	254-1	3	#6 lockwasher
F15	253-9	1	#8 flat washer

WIRE–SLEEVING–LINE CORD

HEATH Part No.	QTY.	DESCRIPTION
344-3	2'	Red stranded wire
344-52	6'	Red solid wire
344-155	16"	Green stranded wire
344-50	6'	Black wire
344-51	4'	Brown wire
344-53	4'	Orange wire
344-54	6'	Yellow wire
344-55	4'	Green wire
344-56	4'	Blue wire
346-1	6"	Small black sleeving
346-21	2"	Teflon sleeving
346-35	2"	Heat shrinkable sleeving
89-54	1	Line cord



KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

TERMINAL STRIP–CONNECTOR BLOCKS–SOCKETS

G1	431-86	1	Terminal strip	
G2	432-874	21	Connector block	
G3	432-880	1	Breadboarding socket (with connectors and vinyl strip)	
G4	434-298	2	14-pin IC socket	
G5	434-230	1	8-pin IC socket	

CABINET–HEAT SINKS

H1	92-775	1	Cabinet top	
H2	92-776	1	Cabinet bottom	
H3	215-99	2	Small heat sink	
H4	215-601	1	Large heat sink	

CLAMP–FUSE–FUSEHOLDER

J1	207-3	1	Cable clamp	
J2	421-31	1	3/16-ampere slow-blow fuse	F101
J3	423-17	1	Fuseholder	
J4	423-18	1	Fuseholder cap	
J5	423-19	1	Fuseholder nut	
J6	423-21	1	Fuseholder washer	

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.

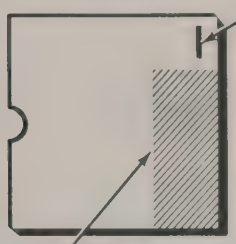
MISCELLANEOUS

K1	204-2539	1	Relief plate	
K2	54-893	1	Power transformer	T101
	85-2572-3	1	Circuit board	
K3	260-700	5	Grommet	
K4	260-701	4	Retainer ring	
K5	261-28	4	Plastic foot	
K6	352-13	1	Silicone grease	
K7	490-111	1	IC puller	
K8	490-5	1	Nut starter	
K9	390-1872	1	FCC compliance label	
K10	390-2092	1	Caution label	
K11	390-2364	1	Heathkit label	
		1	Blue and white label	
	597-260	1	Parts Order Form	
		1	Assembly Manual (See front cover for part number.)	
			Solder.	

STEP-BY-STEP ASSEMBLY

IDENTIFICATION DRAWING

PART NUMBER



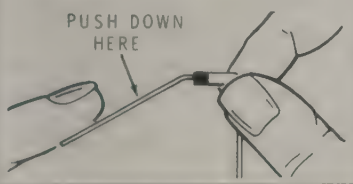
The steps performed in this Pictorial are in this area of the circuit board.

START

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on a circuit board.

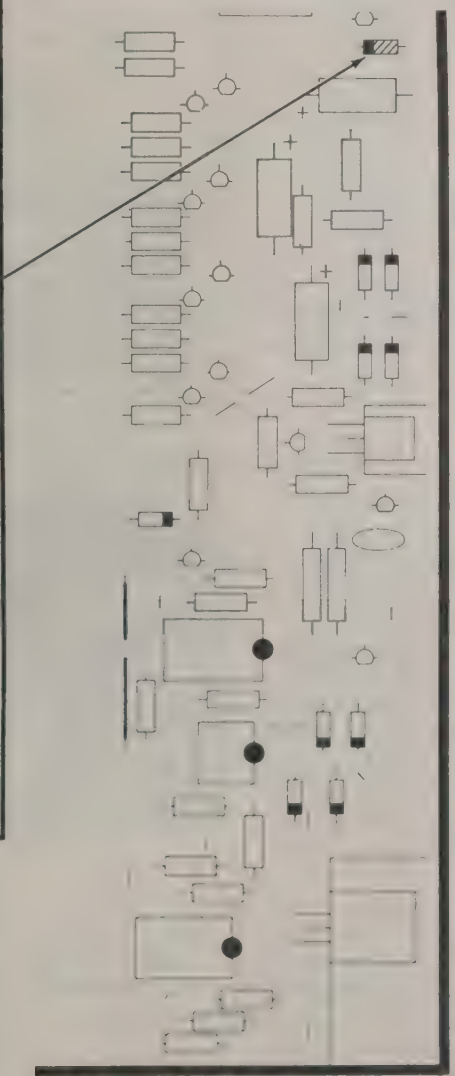
( ) Position the circuit board as shown with the printed side (not the foil side) up.

( ) ZD1: Hold a 1N3017 zener diode (#56-97) by the body. Position the printed value up and bend the leads straight down, as shown.



( ) Push the leads through the holes at the indicated location on the circuit board. Be sure to position the banded end as shown on the circuit board.

( ) Press the diode against the circuit board. Then bend the leads outward slightly to hold the diode in place.

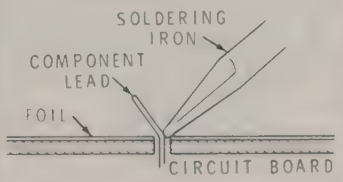


PICTORIAL 1

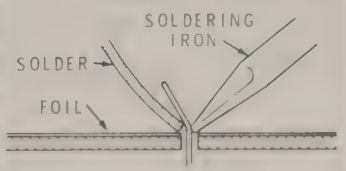
CONTINUE

( ) Solder the diode leads to the circuit board as follows:

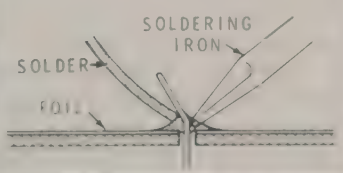
1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



2. Then apply solder to the other side of the connection. IMPORTANT: Let the heated lead and the circuit board foil melt the solder.



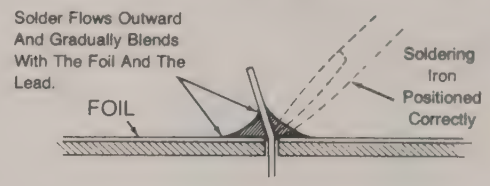
3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.



( ) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

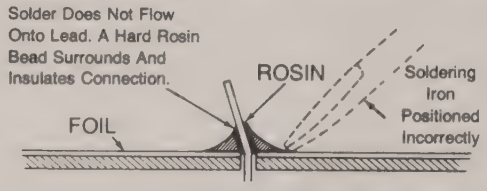
( ) Check each connection. Compare it to the illustrations on Page 10. After you have checked the solder connections, proceed with the assembly on Page 11. Use the same soldering procedure for each connection.

A GOOD SOLDER CONNECTION

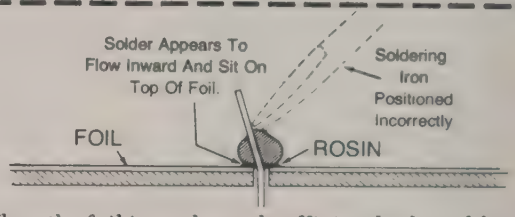


When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS


Solder Does Not Flow Onto Lead. A Hard Rosin Bead Surrounds And Insulates Connection.
ROSIN
FOIL
Soldering Iron Positioned Incorrectly

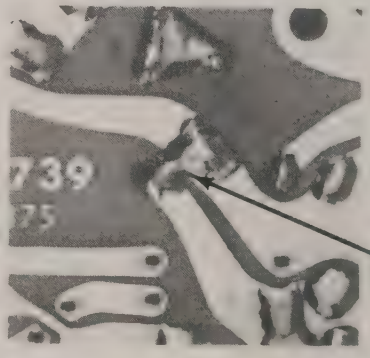
When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.



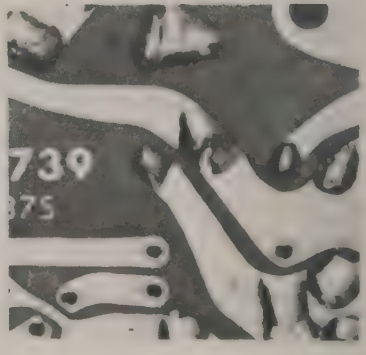
When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

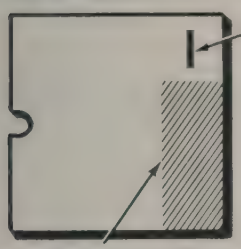


Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.



Heathkit

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Make sure you installed ZD1 on Pictorial 1-1 before you proceed.

When a wire is called for, cut a yellow wire to the specified length. Then remove 1/4" of insulation from each end. Solder each wire end to the foil as you install it and cut off the excess wire ends.

( ) 1" wire.

( ) 3/4" wire. Remove all the insulation from the wire.

( ) 1-3/4" wire.

( ) R46: 15 kΩ (brown-green-orange).

Install four 1000 Ω (brown-black-red) resistors, at:

( ) R31

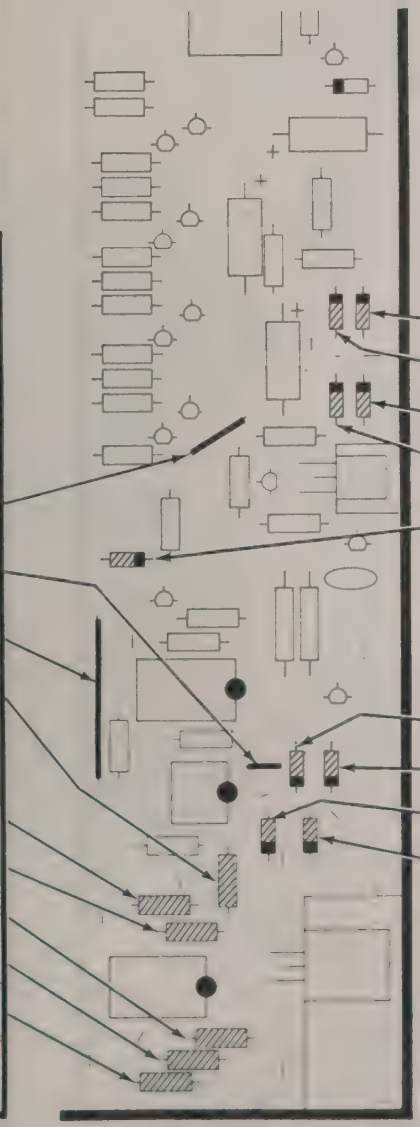
( ) R28

( ) R36

( ) R34

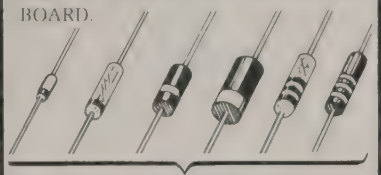
( ) R39: 470 Ω (yellow-violet-brown).

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



BANDED END

Install four 1N4002 diodes (#57-65), at:

( ) D5.

( ) D6.

( ) D8.

( ) D7.

( ) D9: 1N4149 diode (#56-56).

( ) Solder the leads to the foil and cut off the excess lead lengths.

Install four 1N4002 diodes (#57-65), at:

( ) D3

( ) D4

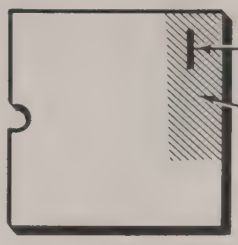
( ) D2

( ) D1

( ) Solder the leads to the foil and cut off the excess lead lengths

PICTORIAL 1-2

IDENTIFICATION DRAWING



PART NUMBER

The steps performed in this Pictorial are in this area of the circuit board.

START

FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) R22: 4700 Ω (yellow-violet-red).

( ) R21: 100 kΩ (brown-black-yellow).

( ) R23: 150 Ω (brown-green-brown).

( ) R25: 4700 Ω (yellow-violet-red).

( ) R24: 100 kΩ (brown-black-yellow).

( ) R26: 150 Ω (brown-green-brown)

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) R29: 4700 Ω (yellow-violet-red).

( ) R27: 100 kΩ (brown-black-yellow).

( ) R32: 150 Ω (brown-green-brown).

( ) R35: 4700 Ω (yellow-violet-red).

( ) R33: 100 kΩ (brown-black-yellow).

( ) R37: 150 Ω (brown-green-brown).

( ) R41: 10 kΩ (brown-black-orange).

( ) R42: 10 kΩ (brown-black-orange).

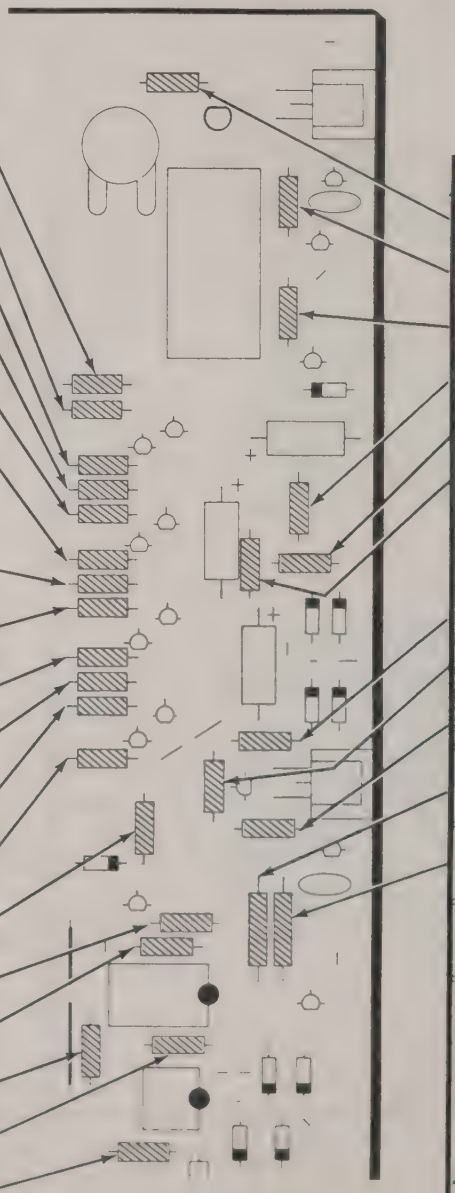
( ) R43: 4700 Ω (yellow-violet-red).

( ) R44: 1000 Ω (brown-black-red).

( ) R45: 1000 Ω (brown-black-red).

( ) R47: 68 kΩ (blue-gray-orange).

( ) Solder the leads to the foil and cut off the excess lead lengths.



PICTORIAL 1-3

CONTINUE

( ) R1: 820 1/2 watt (gray-red-brown).

( ) R4: 4.7 Ω (yellow-violet-gold).

( ) R5: 220 Ω (red-red-brown).

( ) R3: 1000 Ω (brown-black-red).

( ) R2: 510 Ω (green-brown-brown).

( ) R7: 2700 Ω (red-violet-red).

( ) Solder the leads to the foil and cut off the excess lead lengths.

( ) R12: 510 Ω (green-brown-brown).

( ) R14: 4.7 Ω (yellow-violet-gold).

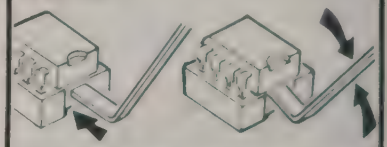
( ) R13: 1000 Ω (brown-black-red).

( ) R18: 2250 Ω, 1% (red-red-green-brown).

( ) R17: 2000 Ω 1% (red-black-black-brown).

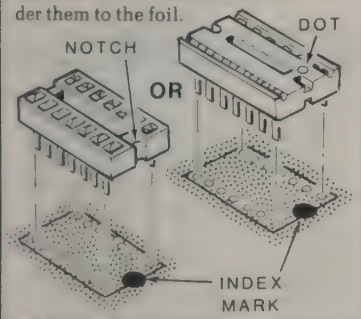
( ) Solder the leads to the foil and cut off the excess lead lengths.

NOTE: On Pictorial 1-3 you will install the integrated circuits (IC's). If you ever have to remove an IC, use the IC puller supplied with your kit as shown below. Insert the foot beneath the IC; then gently rock the tool back and forth to lift the IC.



START

NOTE: Before you install an IC socket, make sure the pins are straight. If there is any kind of identification mark (notch, dot, arrowhead, etc.) at or near one end of the socket, place this marked end toward the index mark on the circuit board (this index mark should still be visible after you install the socket). Then start the pins into the circuit board holes and solder them to the foil.



( ) 14-pin IC socket at IC2.

( ) 8-pin IC socket at IC3.

( ) 14-pin IC socket at IC4.

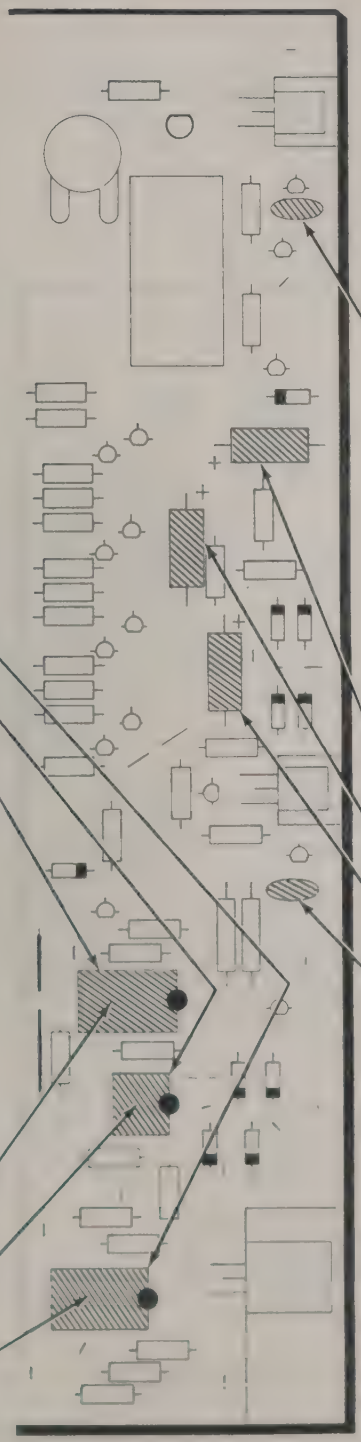
In the following steps, install the integrated circuits (IC's) as follows:

1. Refer to Detail 1-4A (at bottom of right-hand column) and identify the pin 1 end of the IC.
2. Be sure the IC pins are straight.
3. Position the pin 1 end of the IC over the half-moon mark on the circuit board.
4. Carefully install the IC. Make sure all the pins go in their respective holes.

( ) IC4: SN7403N integrated circuit (#443-54).

( ) IC3: NE555V integrated circuit (#442-53).

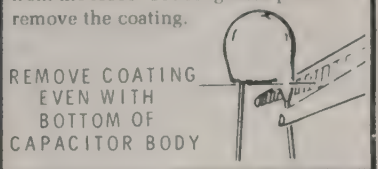
( ) IC2: SN7403N integrated circuit (#443-54).



PICTORIAL 1-4

CONTINUE

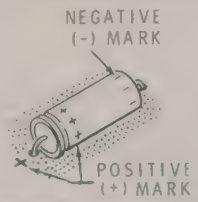
NOTE: When you install disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove the coating.



NOTE: Your kit contains four .001 µF disc capacitors. Do not install the large 21-71 capacitor on this page.

( ) C4: .001 µF disc. Do **not** install a large 21-71 capacitor here.

NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a plus (+) mark or a minus (−) mark near it. **Be sure** to install the positive lead in the positive-marked hole. Be careful; only the negative lead may be marked.



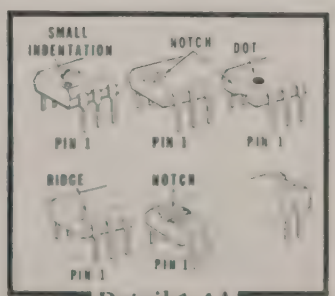
( ) C5: 10 µF electrolytic.

( ) C3: 10 µF electrolytic.

( ) C8: 10 µF electrolytic.

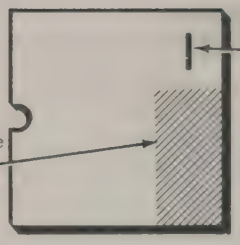
( ) C7: .001 µF disc. Do **not** install a large 21-71 capacitor here.

( ) Solder the leads to the foil and cut off the excess lead lengths.



Detail 1-4A

IDENTIFICATION DRAWING



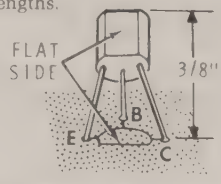
The steps performed in this Pictorial are in this area of the circuit board.

START

( ) R6: 2000 Ω (2K) control. Solder the four lugs to the foil

NOTE: When you install transistors, be sure the top of each transistor is no more than 3/8" above the circuit board.

Insert the transistor leads into the corresponding E, B, and C holes in the circuit board as shown. Solder each lead to the foil and cut off the excess lead lengths.



Install twelve MPSA20 transistors (#417-801), at:

( ) Q1

( ) Q4

( ) Q3

( ) Q9

( ) Q10

( ) Q11

( ) Q12

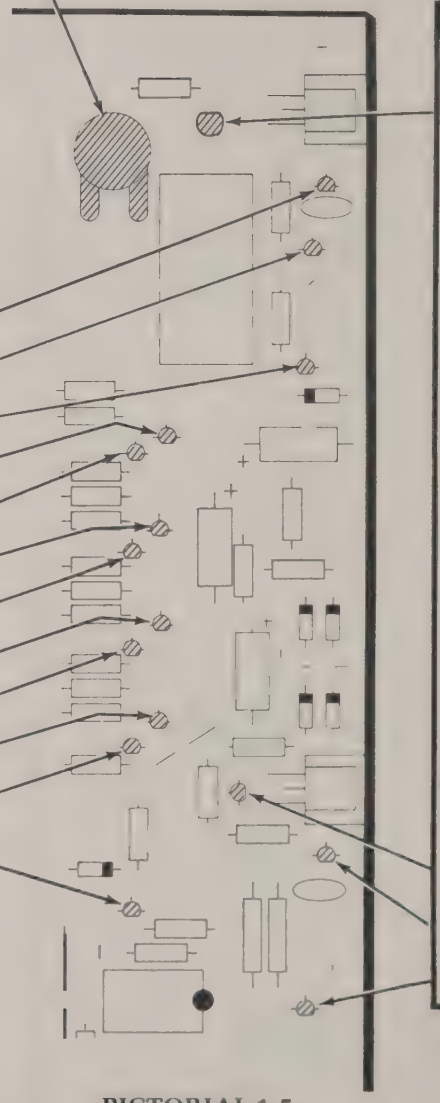
( ) Q13

( ) Q14

( ) Q15

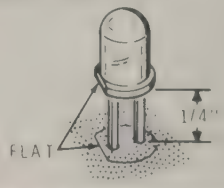
( ) Q16

( ) Q17



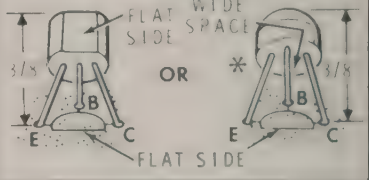
CONTINUE

( ) D11: LED (#412-640). Align the flat of the LED with the flat outline on the circuit board, with the LED 1/4" above the board. Solder the leads to the foil and cut off the excess lead lengths.



NOTE: Install the next three transistors as shown.

*Notice that the transistor marked with an asterisk must be installed with its wide space opposite to the flat marked on the circuit board and its leads installed as shown.



Install three 2N4121 transistors (#417-235), at:

( ) Q8

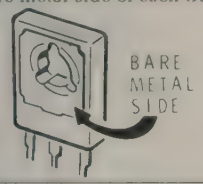
( ) Q5

( ) Q7

PICTORIAL 1-5

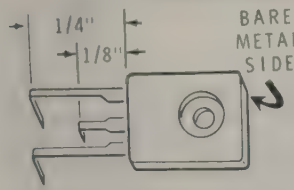
START

( ) Locate the MJE181 transistor (#417-818) and the MJE171 transistor (#417-819). Then open the container of silicone grease and put a liberal amount of grease on the bare metal side of each transistor.



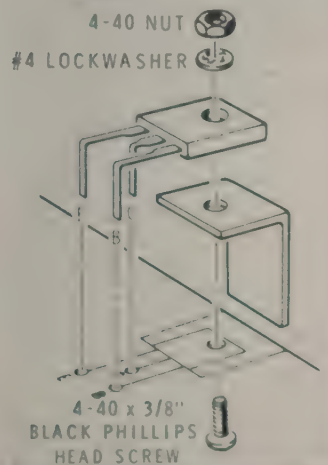
(√) Q2: MJD181 transistor (#417-818) as follows:

1. Position the bare metal side of the transistor down and bend the transistor leads as

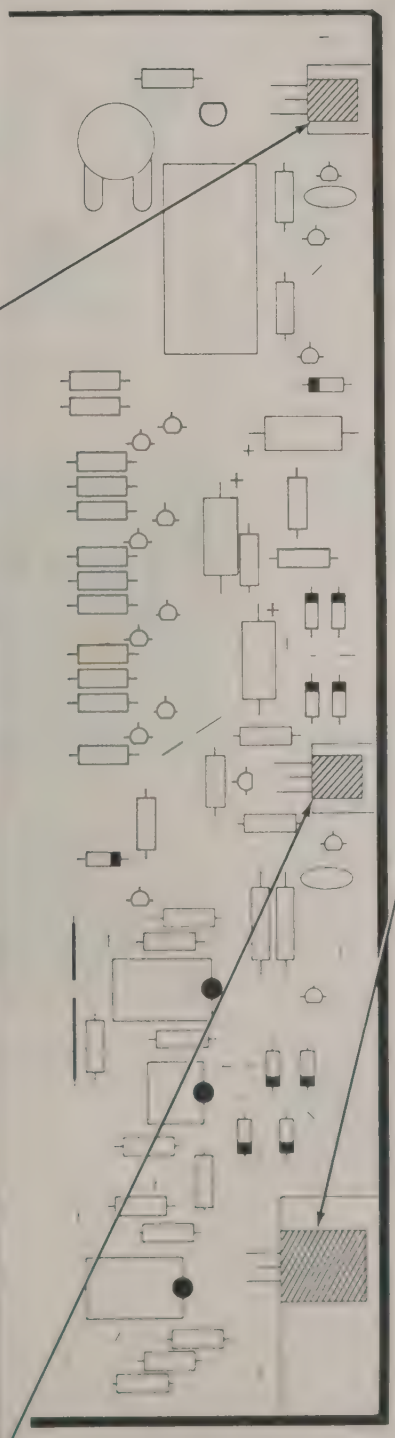


2. Install the E, C, and B leads into the corresponding holes in the circuit board and secure the transistor to the board with a heat sink, #4-40 × 3/8" black phillips head screw, #4 lockwasher, and 4-40 nut. Use the plastic nut starter to hold and start the nuts on the screws. Do not overtighten the screw.

3. Solder the leads to the foil and cut off the excess lead lengths.



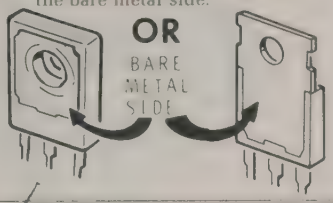
(√) Q6: MJE171 transistor (#417-819). Install this transistor as you did the previous one.



PICTORIAL 1-6

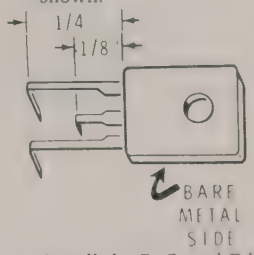
CONTINUE

( ) Locate the μA7805 integrated circuit (#442-54). Then apply a liberal amount of silicone grease to the bare metal side.



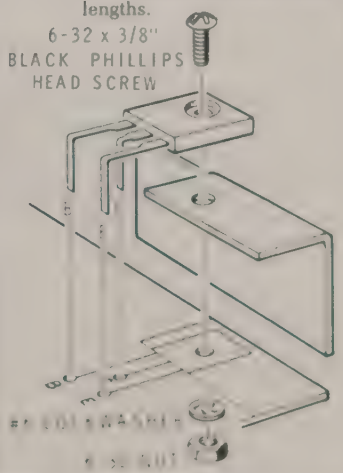
(√) IC1: Install the prepared integrated circuit as follows. Your integrated circuit may look different than the one shown.

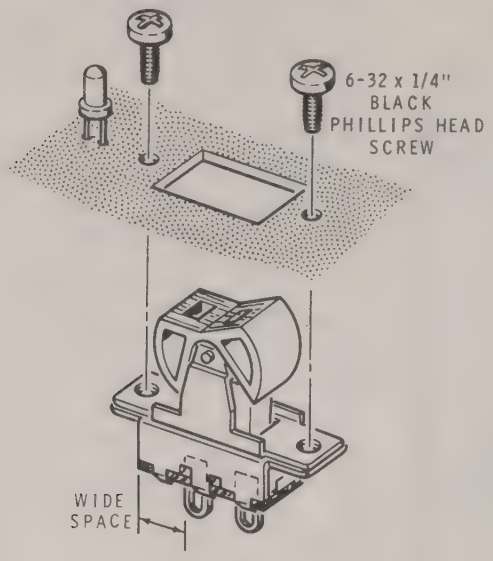
1. Position the bare metal side of the integrated circuit down and bend the leads as shown.



2. Install the B, C, and E leads into the corresponding holes in the circuit board and secure the integrated circuit to the board with a 6-32 × 3/8" black phillips head screw, a large heat sink, a #6 lockwasher, and a 6-32 nut.

3. Solder the leads to the foil and cut off the excess lead lengths.





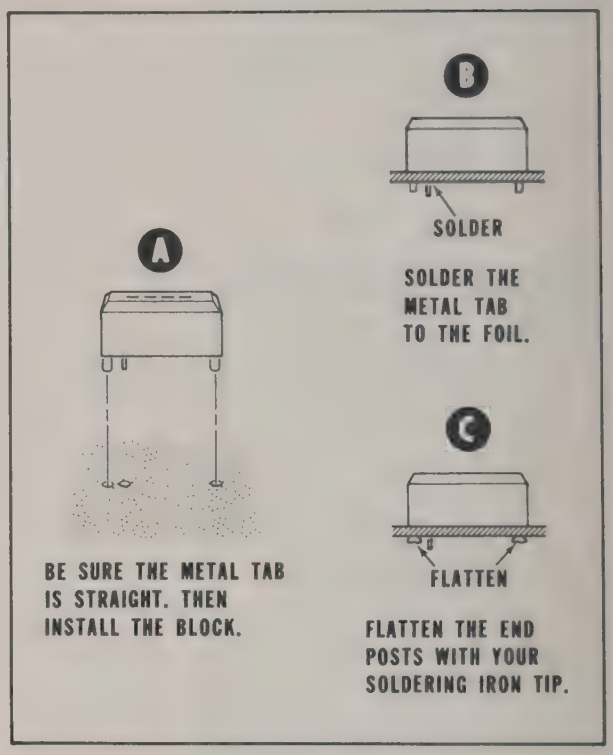
Detail 2-1A

A separate "Illustration Booklet" contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. The Step-by-Step Assembly instructions will direct you to the proper illustration in the Booklet. The illustrations are arranged in Pictorial number sequence. Place the Booklet in a convenient location and keep it with the Assembly Manual.

Refer to Pictorial 2-1 (in the Illustration Booklet Page 3) for the following steps.

( ) Reposition the board as shown.

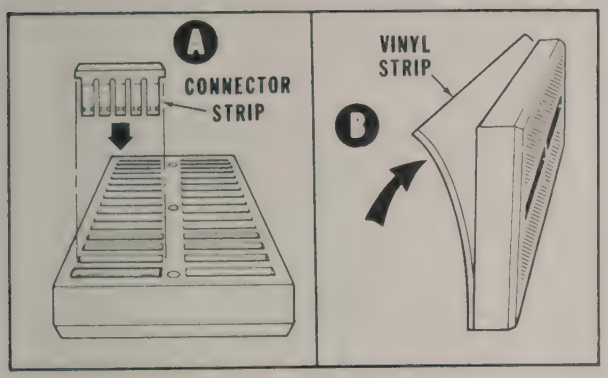
( ) SW101: Refer to Detail 2-1A and mount the SPST rocker switch at SW101 with two 6-32 × 1/4" black phillips head screws. Be sure the switch lugs are positioned as shown in the Pictorial.



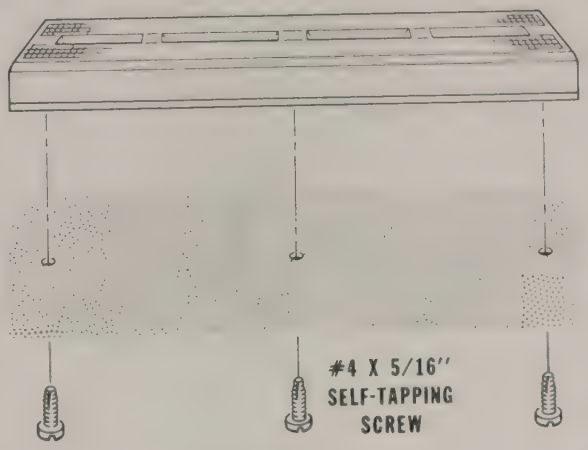
Detail 2-1B

NOTE: In some of the following steps, you will solder to large areas of foil. These connections will require more heat. Hold the soldering iron against the connection until the solder flows smoothly onto the foil.

( ) Refer to Detail 2-1B and install connector blocks at the twenty-one indicated locations.



Detail 2-1C

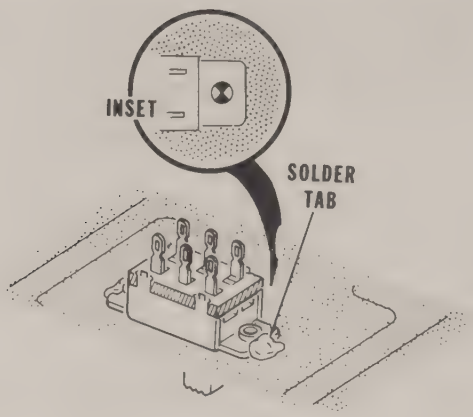


Detail 2-1D

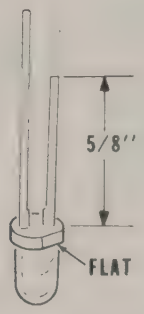
( ) Refer to Part A of Detail 2-1C and install the connector strips, supplied with the breadboarding socket, into the socket. You may have some connector strips left over.

( ) Refer to Part B of Detail 2-1C and remove the paper backing from the vinyl strip supplied with the breadboarding socket. Then line up the long edges of the vinyl strip and socket as shown, and press the sticky side of the vinyl strip against the socket.

( ) Refer to Detail 2-1D, cut three holes through the vinyl strip, and mount the breadboarding socket with three #4 × 5/16″ self-tapping screws as shown.



Detail 2-2A



Detail 2-2B

Refer to Pictorial 2-2 (in the Illustration Booklet Page 3) for the following steps.

( ) Turn the circuit board foil-side-up and position it as shown in the Pictorial.

( ) SW1: Refer to Detail 2-2A. Then center the foil patterns under the switch tab holes (see the inset drawing) and solder one tab of a DPDT slide switch to the foil at SW1. Use only a small amount of solder at only one spot. Then operate the switch to be sure that it works freely and that the switch knob does not rub against the circuit board. Then finish soldering both switch tabs.

In a similar manner, install DPDT slide switches at:

( ) SW2.

( ) SW3.

( ) SW4.

As before, install SPDT slide switches at:

( ) SW5. Position the switch so the knob is as shown in Pictorial 2-2.

( ) SW6. Position the switch so the knob is as shown.

( ) SW7. As before, install the DPTT slide switch.

( ) Locate the four LED's. Then refer to Detail 2-2B and cut the lead near the flat of each LED to 5/8".

( ) L4. Refer to Detail 2-2C and install an LED as follows:

1. Push the plastic grommet into the hole, from the top side of the circuit board, as far as it will go.

2. Push the LED all the way down into the grommet. Position the shorter lead as shown in Pictorial 2-2.

3. Place the retainer ring over the LED and press the ring down around the grommet as far as it will go.

In a similar manner, install LED's at:

( ) L3.

( ) L2.

( ) L1.

NOTES:

1. When you solder a lead or wire to the foil in the following steps, lay the lead end flat on the foil and solder it to the foil. If the lead tries to spring up off the foil, hold it down with the blade of a screwdriver until the solder cools.

2. In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following the "S" tells how many wires are at the connection.

Solder the leads of the LED's to the foil as follows:

L4

( ) Shorter lead to foil T (S-1).

( ) Other lead to foil U(S-1).

L3

( ) Shorter lead to foil V (S-1).

( ) Other lead to foil W (S-1).

L2

( ) Shorter lead to foil X (S-1).

( ) Other lead to foil Y (S-1).

L1

( ) Shorter lead to foil Z (S-1).

( ) Other lead to foil AA (S-1).

( ) **Cut the leads of four 150 kΩ (brn-grn-yel) resistors to 1/4". Bend the leads of each resistor 90-degrees to the resistor body.**

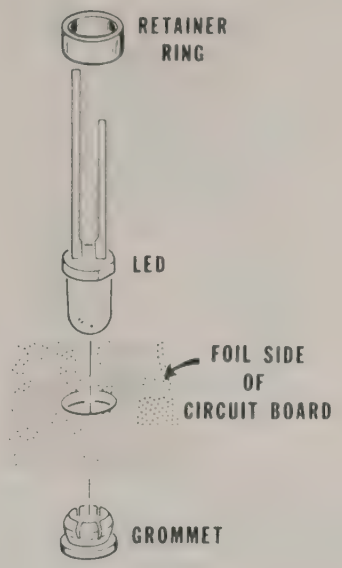
Refer to inset drawing #1 on Pictorial 2-2 and mount each of the four 150 kΩ resistors onto the circuit board, in the following steps, exactly as shown. Heat the foil pads, position the resistor leads into the melted solder, and then remove the heat. Hold the resistor steady in the connection until the solder has cooled.

( ) **R48: 150 kΩ resistor.**

( ) **R49: 150 kΩ resistor.**

( ) **R51: 150 kΩ resistor.**

( ) **R52: 150 kΩ resistor.**



Detail 2-2C

( ) Cut four 2" yellow wires. Then remove 1/4" of insulation from one end of each wire and 1/2" of insulation from the other end.

( ) Insert the longer bare end of a 2" yellow wire through switch SW4 lugs 2 and 5, and solder the connections. Then solder the free end of the wire to foil K.

Similarly install the other three 2" yellow wires as follows:

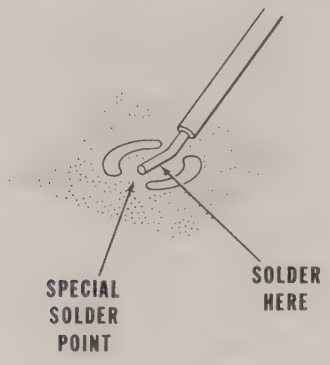
( ) 2" yellow wire between switch SW3 lugs 2 and 5, and foil L. Solder the connections.

( ) 2" yellow wire between switch SW2 lugs 2 and 5, and foil M. Solder the connections.

( ) 2" yellow wire between switch SW1 lugs 2 and 5, and foil N. Solder the connections.

NOTE: When a bare wire is called for, first remove the indicated length of insulation from the yellow wire. Then cut off and use the bare wire.

( ) Prepare a 3-3/4" bare wire.



Detail 2-2D

NOTE: On some large areas of the foil, special solder points have been prepared to make soldering easier. Portions of foil have been etched away so solder connections will not require as much heat. When you are instructed to, use these special solder points as shown in Detail 2-2D.

( ) Insert the bare wire through switches SW4, SW3, SW2, and SW1 — lugs 4 and 1 of each switch. Then solder the wire to the switch lugs and solder the free end to special solder point J as shown.

( ) Prepare a 4-1/4" yellow wire. Then remove an additional 2-3/4" of insulation from one end.

( ) Insert the long bare wire end through switches SW4, SW3, SW2, and SW1 — lugs 6 and 3 of each switch. Then solder the wire to the switch lugs and solder the free end to foil E.

( ) Prepare the following yellow wires:

QUANTITY	LENGTH
2	1-3/4"
1	2"
2	2-1/2"
1	2-3/4"
1	3-1/4"

( ) Remove an additional 3/8" of insulation from one end of a 2-1/2" yellow wire. Then insert this wire end through switch SW7 lugs 7 and 3, to lug 2. Solder the wire to the switch lugs and solder the free wire end to foil H.

NOTE: In the following step, be sure you position positive (+) lead as indicated.

( ) C9: Cut both leads of the 10 μF tantalum capacitor to 1/2". Connect the positive (+) marked lead to foil S (S-1) and connect the other lead to switch SW7 lug 1 (S-1).

( ) C10: Cut one lead of the .01 μF Mylar capacitor to 1/2" and cut the other lead to 3/4". Then cut a 1/2" length of small black sleeving and slide it onto the 3/4" lead. Connect this lead to switch SW7 lug 6 (S-1) and connect the other lead to foil R (S-1).

( ) C11: Cut both leads of the 62 pF mica capacitor to 1/2". Connect one lead to switch SW7 lug 4 (S-1) and connect the other lead to foil P (S-1).

NOTE: In some of the following steps, you will install wires in circuit board holes. Leave the wire insulation 1/8" from the circuit board so you can solder the connection. Then lightly tug on the wire to be sure it is properly soldered. See inset drawing #1 on the Pictorial.

Connect the following prepared yellow wires to switch SW5.

( ) 2-1/2" wire from lug 3 (S-1) to hole D (S-1).

( ) 1-3/4" wire from lug 2 (S-1) to foil G (S-1).

( ) 3-1/4" wire from lug 1 (S-1) to hole B (S-1).

Connect the following prepared yellow wires to switch SW6.

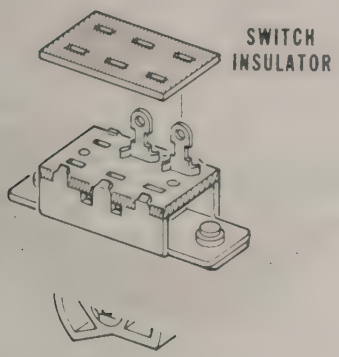
( ) 2" wire from lug 3 (S-1) to hole C (S-1).

( ) 1-3/4" wire from lug 2 (S-1) to foil F (S-1).

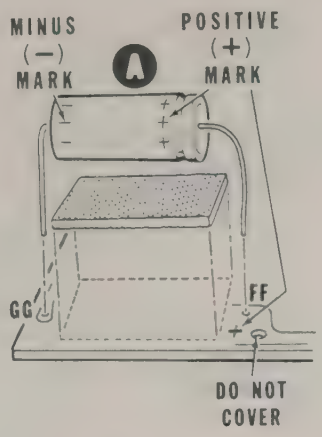
( ) 2-3/4" wire from lug 1 (S-1) to hole A (S-1).

( ) Refer to Detail 2-2E and position the switch insulator down over the lugs of switch SW101.

( ) Prepare two 12" red **stranded** wires.



Detail 2-2E



Detail 2-2F

( ) Connect one 12" red wire to switch SW101 lug 1 (S-1). Wrap the lead securely around the lug. The free end will be connected later.

( ) Connect the other 12" red wire to switch SW101 lug 2 (S-1). Wrap the lead securely around the lug. The free end will be connected later.

( ) Cut two 1" pieces of heat-shrinkable sleeving for use in the following step.

( ) Slide a piece of sleeving over each 12" red wire. Push the sleeving over the switch lugs and shrink it in place with a lighter or a match. (See inset drawing #3.)

( ) Cut three 1-1/2" lengths of foam tape.

NOTE: As you install foam tape in the following steps, first check the circuit board foils to be sure there are no solder bridges. Then press the tape into place.

( ) Refer to Detail 2-2F. Then remove the paper backing from one side of one length of foam tape, and apply the tape between holes GG and FF as shown.

( ) In a similar manner, apply another length of tape between holes EE and DD. Center it between the holes.

( ) In a similar manner, apply another length of tape between holes CC and BB. Center it between the holes.

( ) Locate the two 1000 μF electrolytic capacitors and the 2200 μF electrolytic capacitor, and cut each lead to 1".

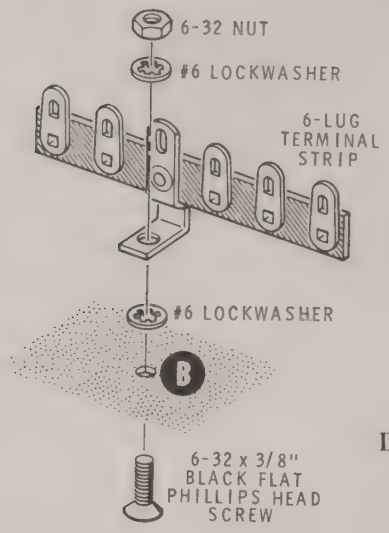
NOTE: Before you install an electrolytic capacitor, look at it and identify the leads. One lead will have a plus (+) mark or a minus (−) mark near it. **Be sure** to install the positive lead in the positive-marked hole. Be careful; only the negative lead may be marked.

( ) C1: Refer to Detail 2-2F, remove the protective paper backing from the foam tape, and install the prepared 1000 μF electrolytic capacitor at holes GG (S-1) and FF (S-1) as shown.

( ) C6: In a similar manner, install another 1000 μF electrolytic capacitor at holes DD (S-1) and EE (S-1).

( ) C2: In a similar manner, install the 2200 μF electrolytic capacitor at holes BB (S-1) and CC (S-1).

( ) Set the circuit board aside temporarily.



Detail 3-1A

Refer to Pictorial 3-1 (in the Illustration Booklet Page 4) for the following steps.

( ) Refer to Detail 3-1A and mount the terminal strip at B in the cabinet bottom as shown. Use a 6-32 × 3/8" black flat phillips head screw, two #6 lockwashers, and a 6-32 nut.

( ) Refer to Detail 3-1B and prepare the leads of the toroid coil as shown.

L101: Connect the prepared toroid coil to terminal strip B as follows:

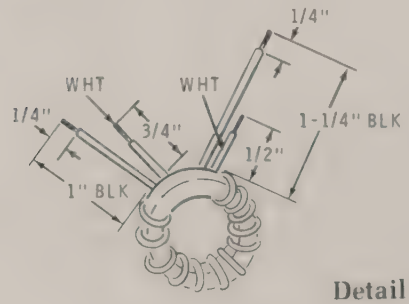
( ) 1-1/4" black lead to lug 2 (NS).

( ) 1/2" white lead to lug 4 (NS).

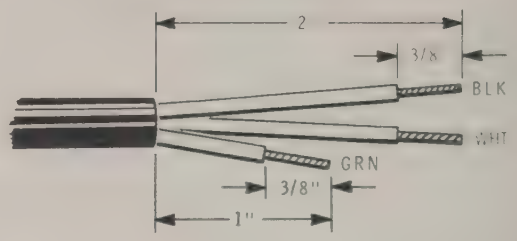
( ) Other white lead to lug 5 (NS).

( ) Other black lead to lug 6 (NS).

( ) Carefully position the coil as shown.



Detail 3-1B



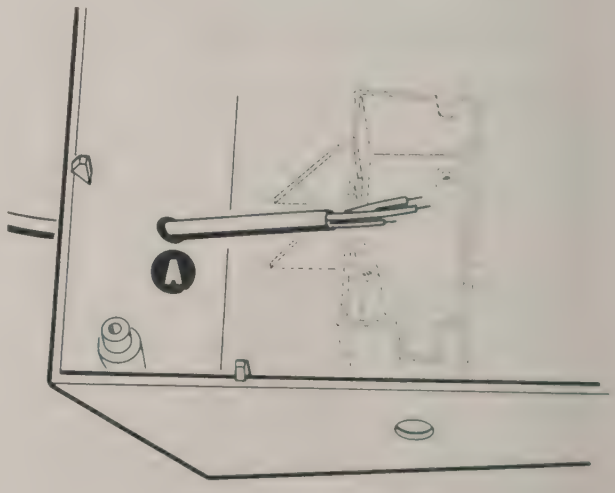
Detail 3-1C

( ) Refer to Detail 3-1C and carefully remove the outer insulation from the end of the line cord opposite the plug as shown.

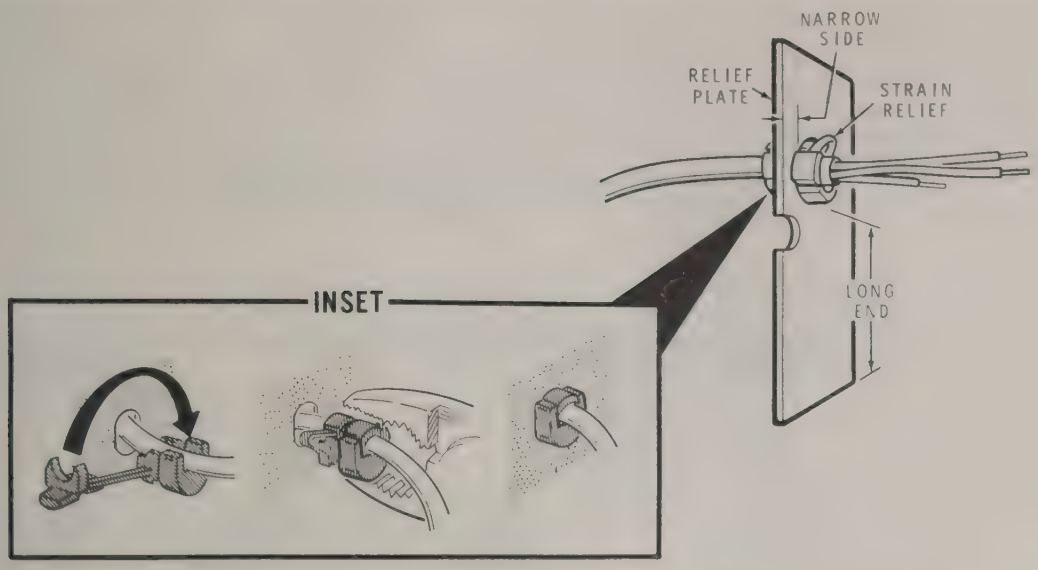
( ) Again refer to Detail 3-1C and prepare this end of the line cord as shown.

( ) Tightly twist the bare wire ends and apply a small amount of solder to the ends to hold the small strands together.

( ) Refer to Detail 3-1D and push the end of the line cord through hole A (from the outside of the cabinet bottom).



Detail 3-1D



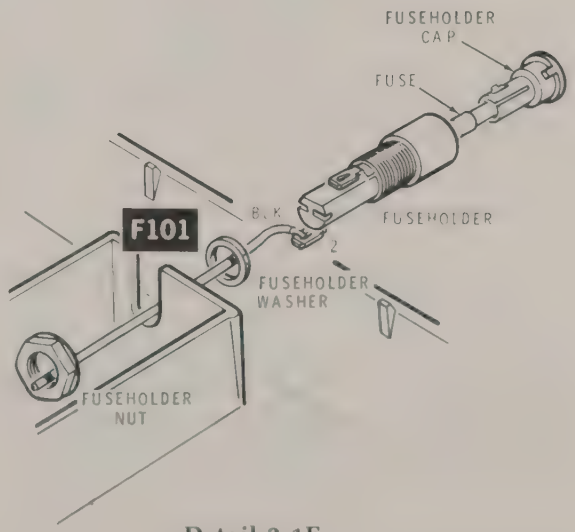
Detail 3-1E

( ) Refer to Detail 3-1E, position the relief plate with the long end and narrow side as shown, insert the end of the line cord through the plate, and install the strain relief on the line cord as shown in the inset drawing.

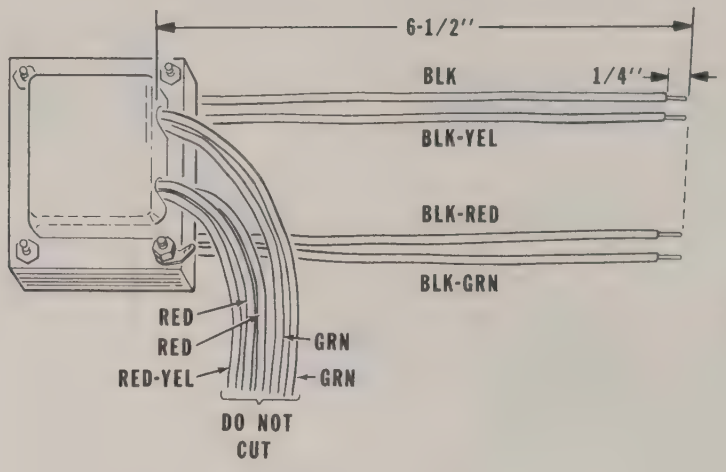
( ) Refer to Detail 3-1F and slide the fuseholder washer, and fuseholder nut onto the fuseholder. Then position the fuseholder near the line cord and connect the black line cord lead to lug 2 of the fuseholder (S-1). Be sure to connect the wire to the side of the lug as shown.

( ) F101: Install the 3/16-ampere slow-blow fuse into the fuseholder cap. Then insert the fuse and cap into the fuseholder. Push and turn the cap with a screwdriver slightly clockwise to lock it in place.

( ) Again refer to Detail 3-1F and mount the fuseholder at F101 as shown.



Detail 3-1F



Detail 3-1G

NOTE: In the following steps, be sure to make mechanically secure connections. Wrap the lead ends securely around the lugs.

( ) Connect the white line cord lead to terminal strip B lug 5 (NS).

( ) Connect the green line cord lead to terminal strip B lug 3 (NS).

NOTE: If you intend to operate your unit with 240 VAC line voltage, you will have to replace the .047 µF Mylar capacitor in the next step with a U.L. rated .047 µF, 250 VAC capacitor (not supplied). The capacitor in the next step is rated for 120 VAC only.

( ) Cut one lead of the .047 µF Mylar capacitor to 1" and the other end to 1/2".

( ) Cut a 3/4" length of Teflon sleeving and slide it over the 1" lead of the capacitor.

( ) Cut a 1/4" length of sleeving and slide it over the 1/2" lead of the capacitor.

( ) C101: Connect the longer lead of the prepared capacitor to terminal strip B lug 6 (NS) and the other lead to terminal strip B lug 5 (S-3).

( ) Refer to Detail 3-1G and prepare the transformer leads as shown. Measure the leads from where they come out of the transformer. Twist the bare ends and apply a small amount of solder to them, if necessary.

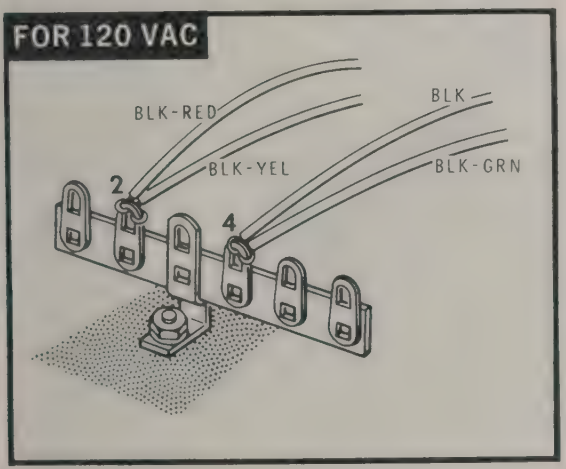
( ) T101: Refer to Pictorial 3-1 and install the power transformer (with the red and green leads up) as shown. Use two #6 × 1-1/8" self-tapping screws.

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 VAC and the other for 240 VAC. In the United States 120 VAC is most common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

WARNING: Before wiring your unit for 240 VAC, you must remove the .047 µF Mylar capacitor (C101). You may replace this capacitor with a U.L. rated .047 µF, 250 VAC capacitor (not supplied).

FOR 120 VAC



Detail 3-1H

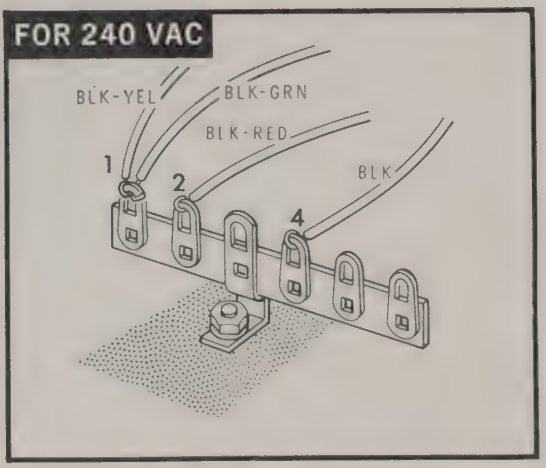
Refer to Detail 3-1H for the following steps. In these steps, make connections to terminal strip B. Wrap the lead ends tightly at the connections. Connect four of the power transformer leads as follows:

( ) Black-red and black-yellow leads to lug 2 (NS).

( ) Black-green and black leads to lug 4 (NS).

Proceed to "Final Wiring."

FOR 240 VAC



Detail 3-1J

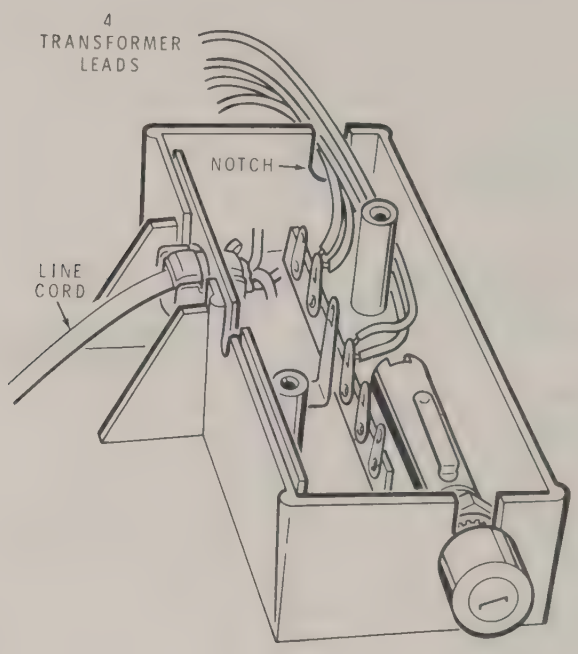
Refer to Detail 3-1J for the following steps. In these steps, make connections to terminal strip B. Wrap the lead ends tightly at the connections. Connect four of the power transformer leads as follows:

( ) Black-yellow and black-green leads to lug 1 (S-2).

( ) Black-red lead to lug 2 (NS).

( ) Black lead to lug 4 (NS).

Proceed to "Final Wiring."



Detail 3-1K

FINAL WIRING

( ) Slide the line cord relief plate into place. Be sure it is up against the wall of the box.

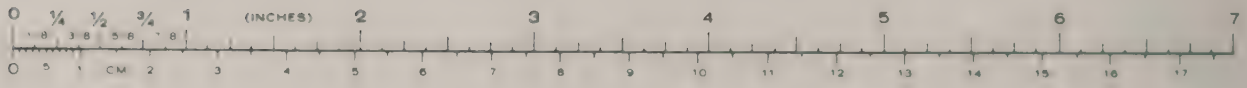
( ) Refer to Detail 3-1K and neatly route the leads and wires as shown.

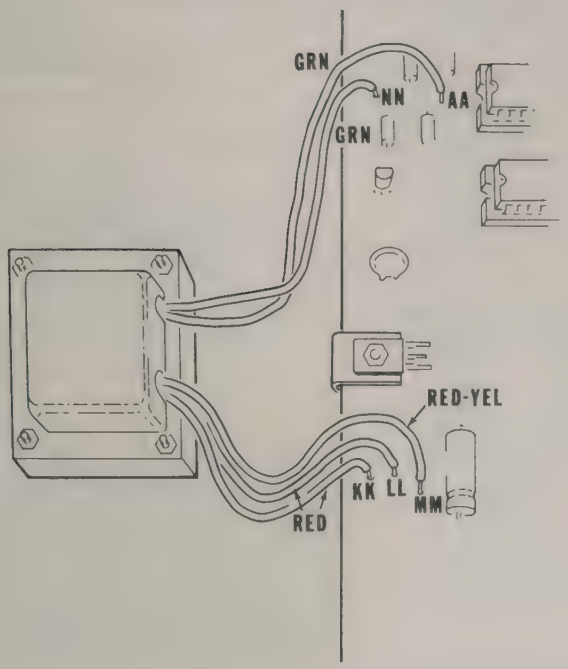
( ) Cut both leads of two .001 μF capacitors to 3/8".

( ) C102: Connect one capacitor between terminal strip B lugs 2 (S-4) and 3 (NS). Position the capacitor below the top of the nearby stud.

( ) C103: Connect the other capacitor between terminal strip B lugs 3 (NS) and 4 (S-4). Position the capacitor below the top of the stud.

( ) **Prepare a 4" green stranded wire and connect one end of it to terminal strip B lug 3 (S-4). The free end will be connected later.**





Detail 3-1L

Refer to Detail 3-1L and connect the remaining transformer leads to the component side of the circuit board as follows:

( ) Either red lead to hole KK (S-1).

( ) Other red lead to hole LL (S-1).

( ) Red-yellow lead to hole MM (S-1).

( ) Either green lead to hole AA (S-1).

( ) Other green lead to hole NN (S-1).

( ) Turn the circuit board over.

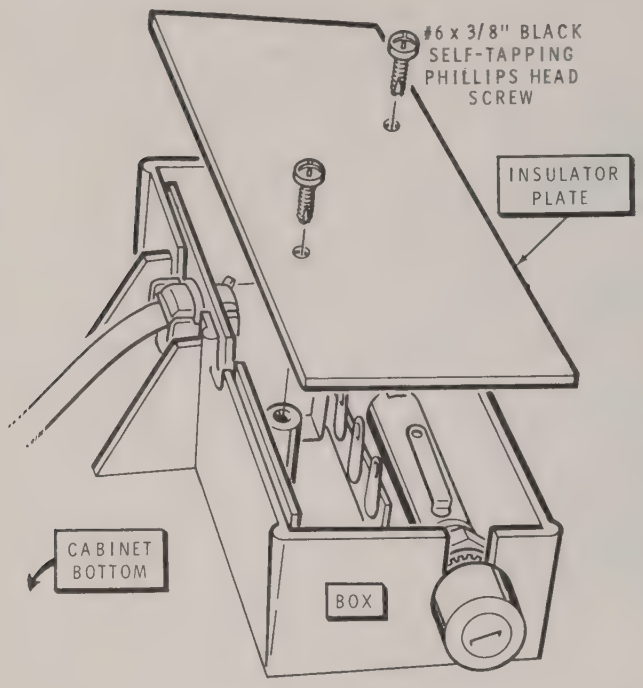
In the following steps, refer to the Pictorial and connect the free ends of the remaining red wires to terminal strip B as follows. Wrap the lead ends tightly around the lugs to form mechanically secure connections.

( ) Connect the wire coming from switch SW101 lug 2 to terminal strip B lug 6 (S-3). Route the wire as shown.

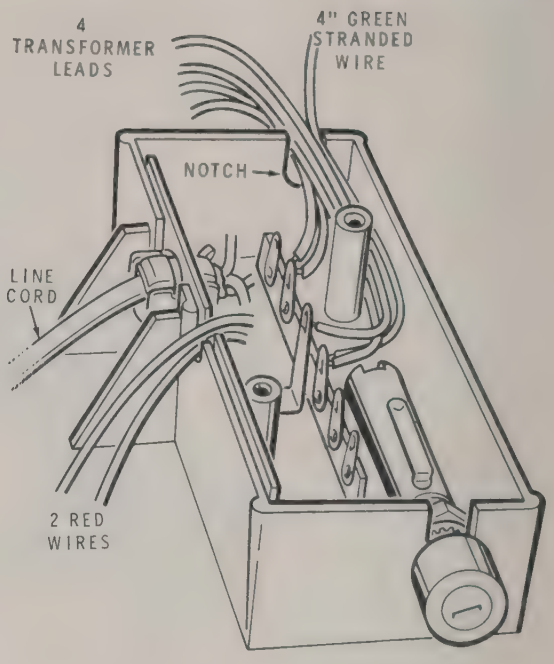
( ) Connect the wire coming from switch SW101 lug 1 to fuseholder F101 lug 1 (S-1).

( ) Connect the 4" green wire coming from terminal strip B lug 3 to power transformer solder lug SL1 (NS).

( ) Prepare a 12" green stranded wire. Connect one end of the wire to SL1 (S-2), and connect the other end to the indicated large foil area of the circuit board (S-1).



PICTORIAL 3-2



Detail 3-2A

Refer to Pictorial 3-2 for the following steps.

( ) Refer to Detail 3-2A and route the leads and wires as shown.

(✓) Mount the insulator plate to the terminal strip box with two #6 × 3/8" black self-tapping phillips head screws. Do not pinch any wires between the plate and box.

This completes the "Step-by-Step Assembly" section. Check the unit over carefully at this time to be sure there are no poor solder connections, solder bridges, loose wire ends, solder splashes, etc. Then proceed to "Test and Adjustments."

TEST AND ADJUSTMENTS

The purpose of this section of the Manual is to make sure your kit operates properly.

Refer to Pictorial 4-1 (in the Illustration Booklet Page 5) for the following steps.

( ) Position the circuit board and cabinet bottom as shown.

( ) Place an insulator (piece of cardboard, etc.) under switch SW101.

CAUTION: In the following steps, do not touch the area marked high-voltage area. High voltage is present here when the line cord is plugged in.

NOTE: If you do not get the proper results in the following steps, unplug the line cord and proceed to "In Case of Difficulty" on Page 40.

( ) Plug in the line cord plug. Lamp D11 should be lit. (If lamp D11 does not light, push switch SW101 to the other position.)

Use a voltmeter to perform the following steps.

( ) Adjust your voltmeter to measure 15 volts DC. Then connect the common lead to the GND small connector block and the probe meter lead to the +12 small connector block. Use short lengths of #22 wire or cutoff component leads to go into the blocks. See inset drawing #1.

( ) Adjust VOLTAGE ADJUST control R6 until the voltmeter indicates 12 volts.

( ) Connect the probe lead to the +5 small connector block. The meter should indicate 5 volts.

( ) Disconnect the voltmeter leads.

( ) Connect the common voltmeter lead to the −12 small connector block.

( ) Connect the other voltmeter lead to the GND small connector block. The meter should indicate 12 volts.

( ) Disconnect the voltmeter leads and set the meter aside.

NOTE: The LOGIC indicators (L1 through L4) should all be off.

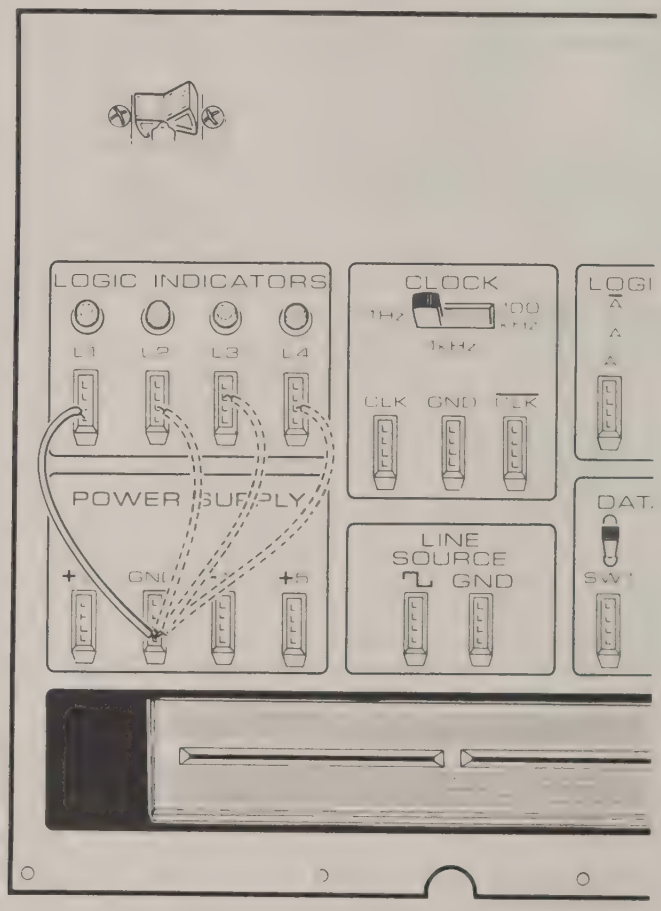
( ) Prepare two 10" black wires.

NOTE: In the following steps, connect the prepared wires to the indicated small connector blocks.

( ) Refer to Detail 4-1A and connect a black wire from GND to L1. Indicator L1 should remain off.

( ) Leave the one wire end connected to GND. Then momentarily connect the other end of the wire to L2, then L3, and then L4. These indicators should remain off.

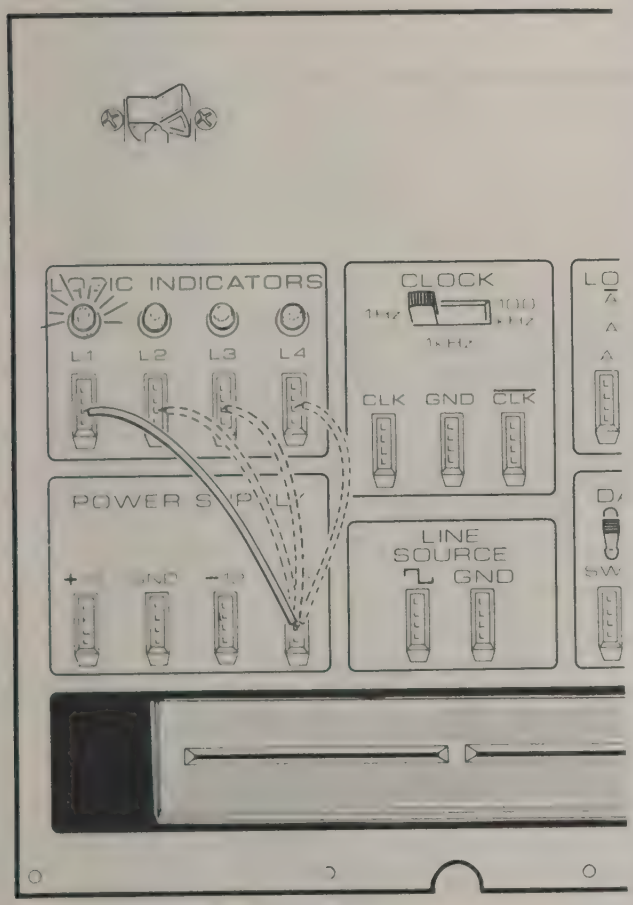
( ) Disconnect the wire.



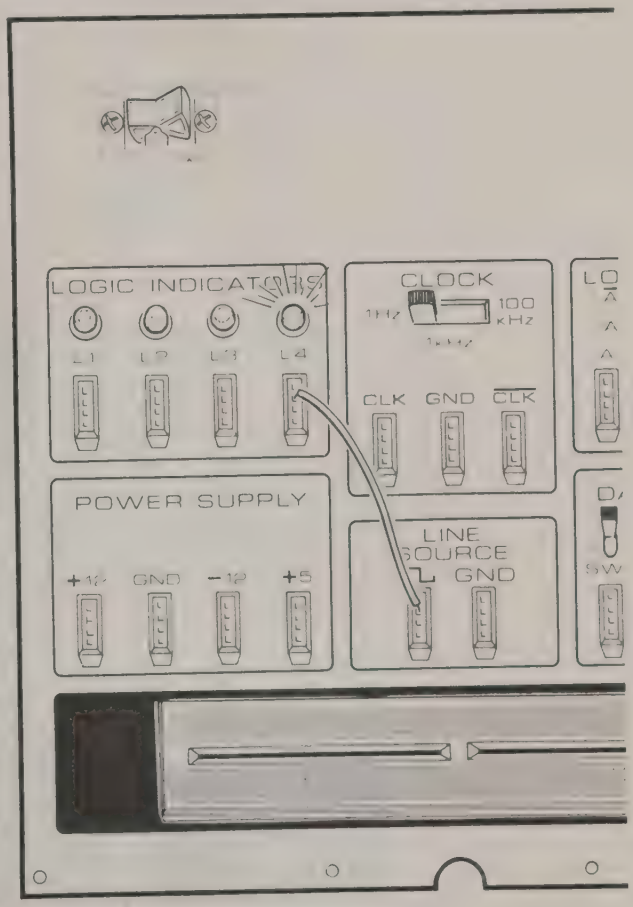
Detail 4-1A

( ) Refer to Detail 4-1B and connect one end of the wire to +5. Then again connect the other end of the wire to L1, then L2, then L3, and then L4. Each indicator should light when you connect the wire to it.

( ) Refer to Detail 4-1C and connect the wire between L4 and LINE SOURCE ⊓⊔ The indicator should light.



Detail 4-1B



Detail 4-1C

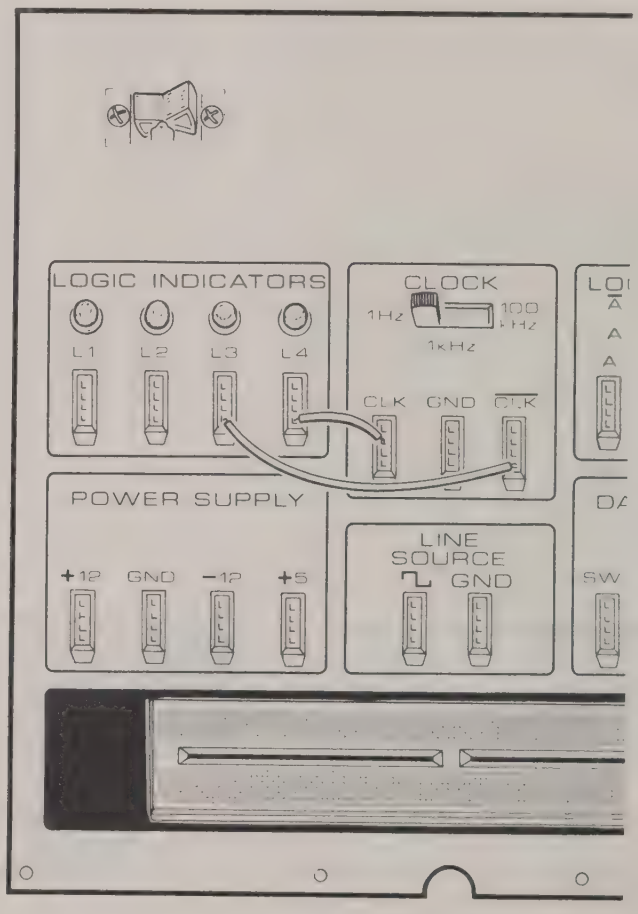
( ) Refer to Detail 4-1D and position the CLOCK switch to the 1 Hz position.

( ) Connect a wire from L4 to CLK.

( ) Connect another wire from L3 to $\overline{\text{CLK}}$. The indicators should blink on and off once each second. When L3 is one, L4 is off; and when L3 if off, L4 is on.

( ) Position the CLOCK switch to the 1 kHz position. The indicators should appear to be on continuously.

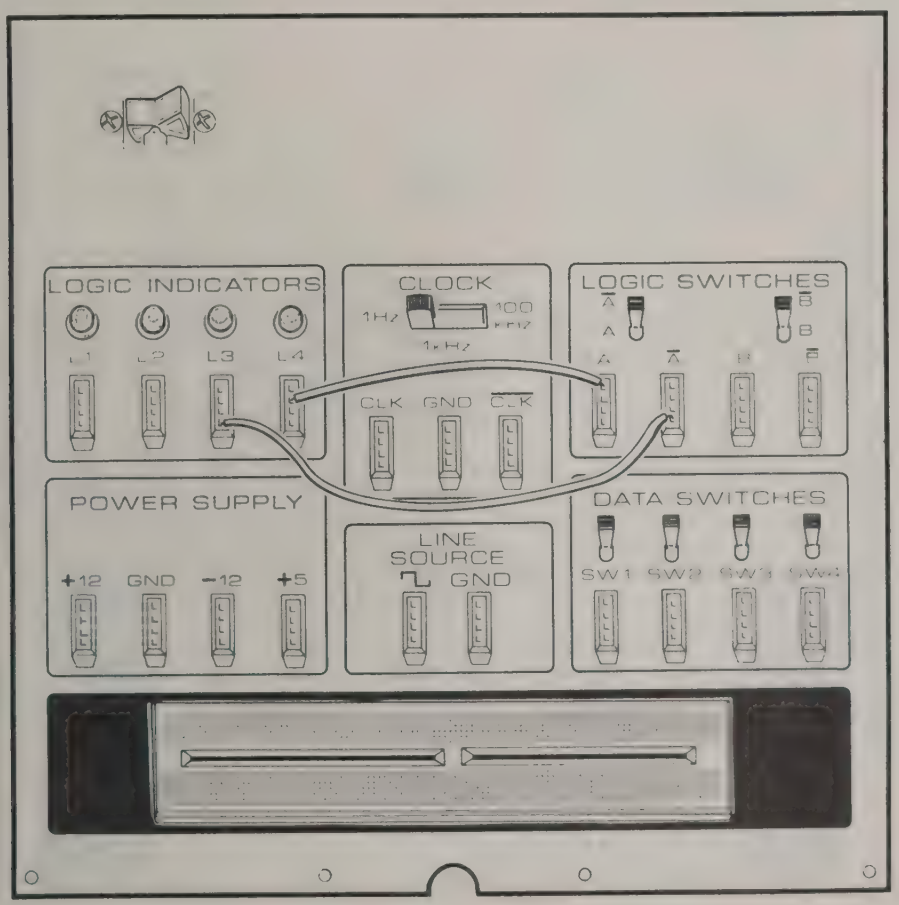
( ) Position the CLOCK switch to 100 kHz. The indicators should again be on, but brighter than before.



Detail 4-1D

( ) Refer to Detail 4-1E and reconnect one wire from L4 to LOGIC switch A.

( ) Reconnect the other wire from L3 to LOGIC switch $\overline{A}$. Then operate swtich A-$\overline{A}$. When the switch is in the $\overline{A}$ (normal) position, indicator L3 should be on and L4 should be off. When the switch is in the A position, L3 should be off and L4 should be on.

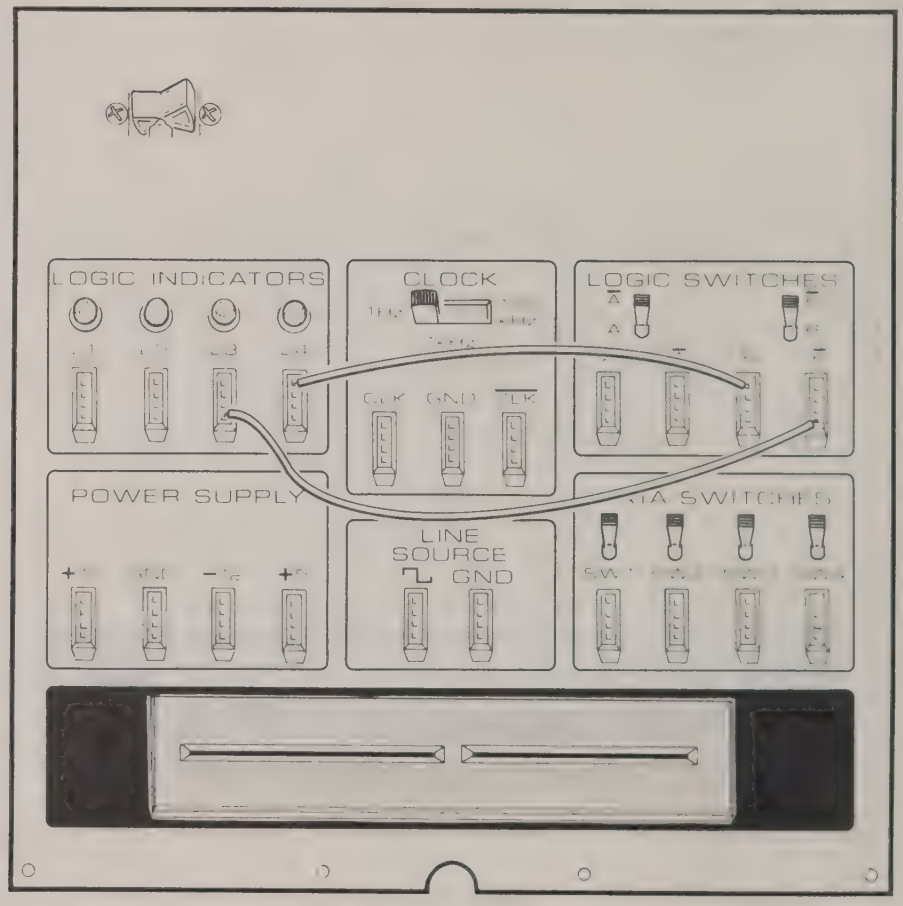


Detail 4-1E

( ) Refer to Detail 4-1F and reconnect one wire from L4 to LOGIC switch B.

( ) Reconnect the other wire from L3 to LOGIC switch $\overline{B}$. Then operate switch B-$\overline{B}$. Again, when the switch is in the $\overline{B}$ position, L3 should be on and L4 should be off. When the switch is in the B position, L3 should be off and L4 should be on.

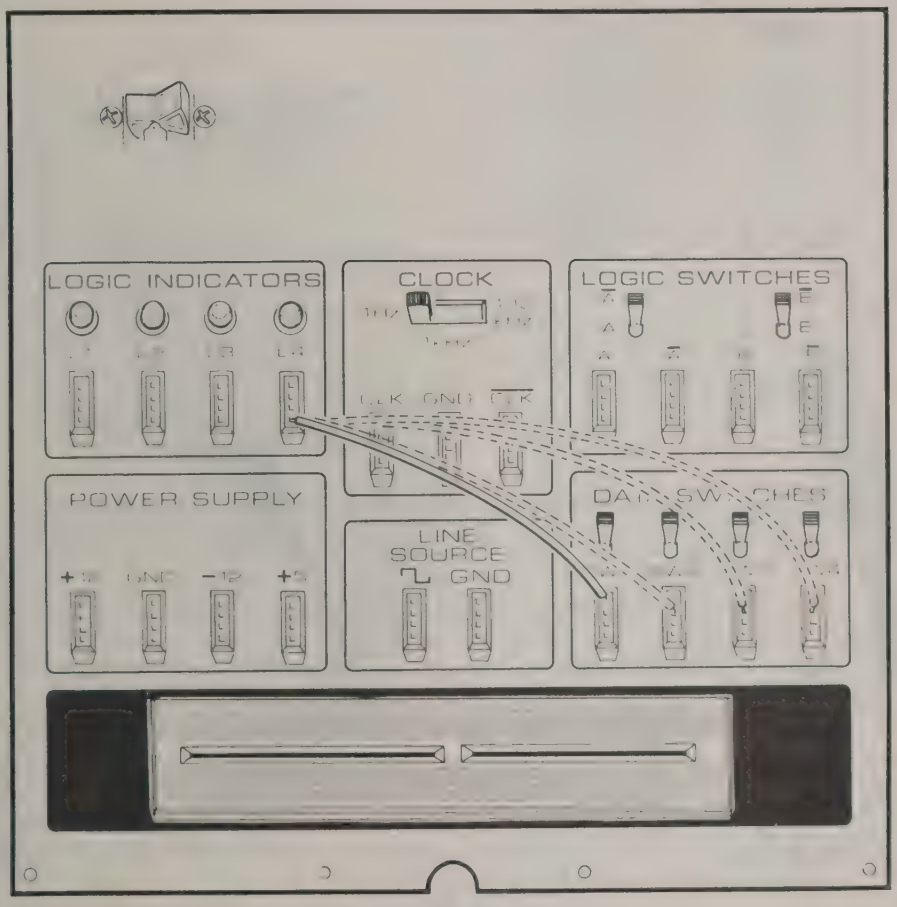
( ) Remove and set aside one of the two wires.



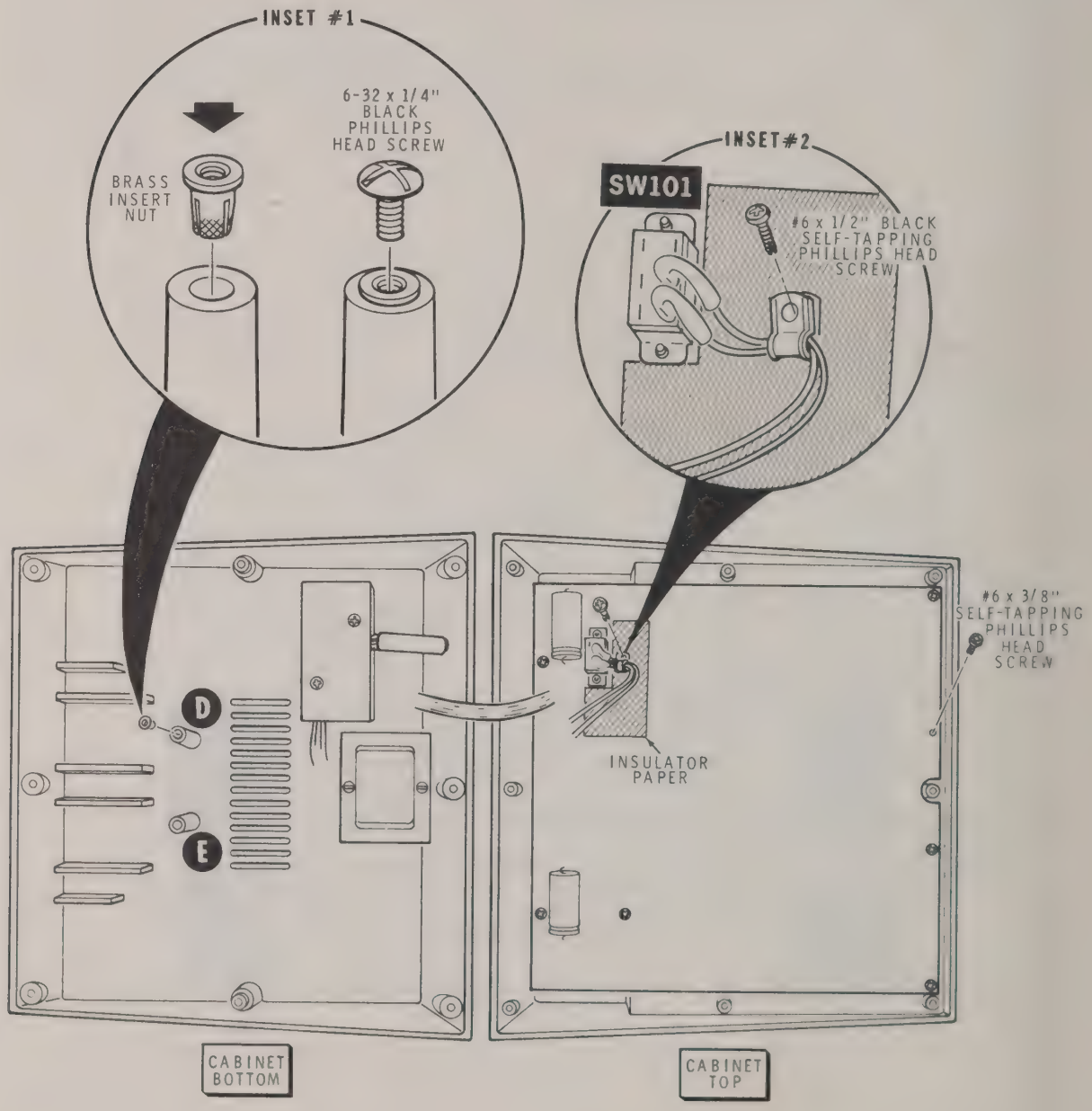
Detail 4-1F

( ) Refer to Detail 4-1G and reconnect the other wire from L4 to DATA switch SW1. Operate the switch. In the up position, L4 should be on. In the down position, L4 should be off.

( ) Perform the above test at DATA switches SW2, SW3, and SW4. Then remove the wire and set it aside.



Detail 4-1G



PICTORIAL 4-2

FINAL ASSEMBLY

Refer to Pictorial 4-1 (in the Illustration Booklet) for the following steps.

( ) Disconnect the line cord plug.

NOTE: Before you install any of the labels in the following steps, clean the area thoroughly with rubbing alcohol.

( ) Remove the protective backing from the Caution label and apply the label to the cabinet bottom as shown. Install it so the printing is upside down.

( ) In a similar manner, install the blue and white identification label. Be sure to refer to the numbers on this label in any communication you have with the Heath Company about this kit.

( ) In a similar manner, install the FCC Compliance label.

( ) Install a plastic foot in the smooth areas at each of the four corners of the cabinet bottom as shown. First remove the protective backing; then press the foot into place.

Refer to Detail 4-1A (Illustration Booklet, Page 5) for the following steps.

( ) Remove the protective backing from the "Heathkit" label and press the label into place on the cabinet top.

( ) Press a grommet into the hole in the cabinet top.

Refer to Pictorial 4-2 for the following steps.

( ) Refer to inset drawing #1 and push a brass insert nut into post D in the cabinet bottom.

( ) Push a brass insert nut into post E in the cabinet bottom.

( ) While you hold the edge of one of the brass insert nuts, turn a 6-32 × 1/4" black phillips head screw into the nut until the nut anchors solidly in the post. Then remove the screw and anchor the other brass insert nut. Then remove the screw again.

( ) Remove the protective backing from the insulator paper and press the paper into position near switch SW101 as shown.

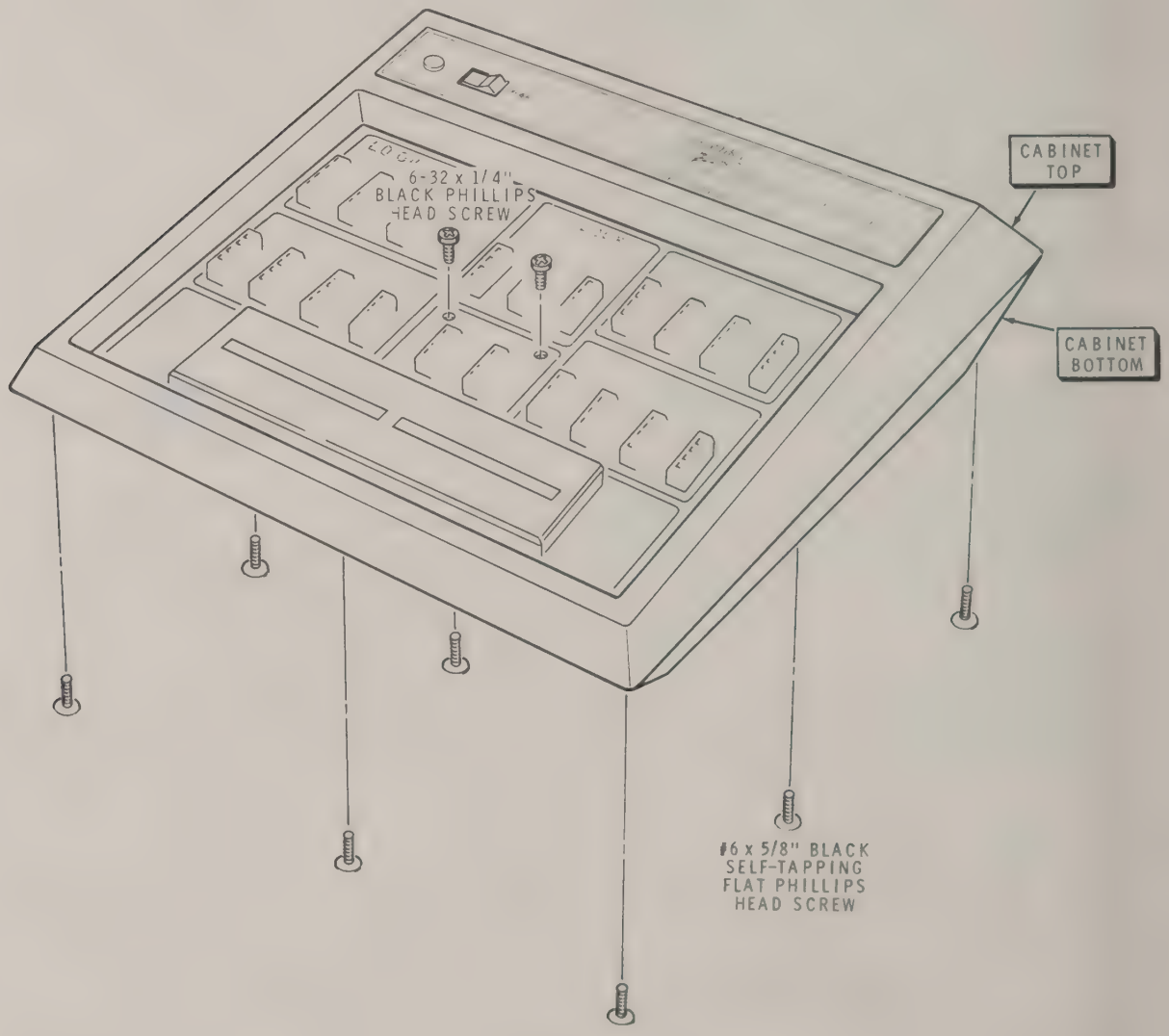
( ) Refer to inset drawing #2 and mount a cable clamp to the two red wires coming from switch SW101. Secure the cable clamp and the circuit board to the cabinet top with a #6 × 1/2" black self-tapping phillips head screw and a # 8 flat washer.

( ) Secure the circuit board to the cabinet top. Use seven #6 × 3/8" black self-tapping phillips head screws as shown.

Refer to Pictorial 4-3 for the following steps.

( ) Mount the cabinet top to the cabinet bottom. Use two 6-32 × 1/4" black phillips head screws and eight #6 × 5/8" black self-tapping flat phillips head screws.

This completes the assembly of your kit. Use the remaining wire for your experiments. (Cut the wire to the desired lengths and remove 1/4" of insulation from the ends.) Proceed to "Operation and Applications."



PICTORIAL 4-3

OPERATION AND APPLICATIONS

The Experimenter not only supplies the common DC voltages used in digital electronics, but it also supplies: a line frequency square wave (60 or 50 Hz); complementary clock signals of 1 Hz, 1 kHz and 100 kHz; logic and data switches to control input levels; and logic indicators to visually monitor logic states and transitions.

Figure 1 gives a brief description of each control function.

CONNECTOR BLOCK

The connector blocks are designed to accept up to #20 (.032") solid wire and most common-component leads. The four connectors in a small connector block are internally connected together. Also, each vertical row of five connectors in the breadboarding socket are connected together as shown in the Figure. Thus, you can build simple or complex circuits without making solder connections.

Page 36 shows an example of a typical experiment. The breadboarding socket is designed to accommodate integrated circuits and the IC puller supplied in your kit fits down into the center channel of the breadboarding socket to gently and easily lift the IC out.

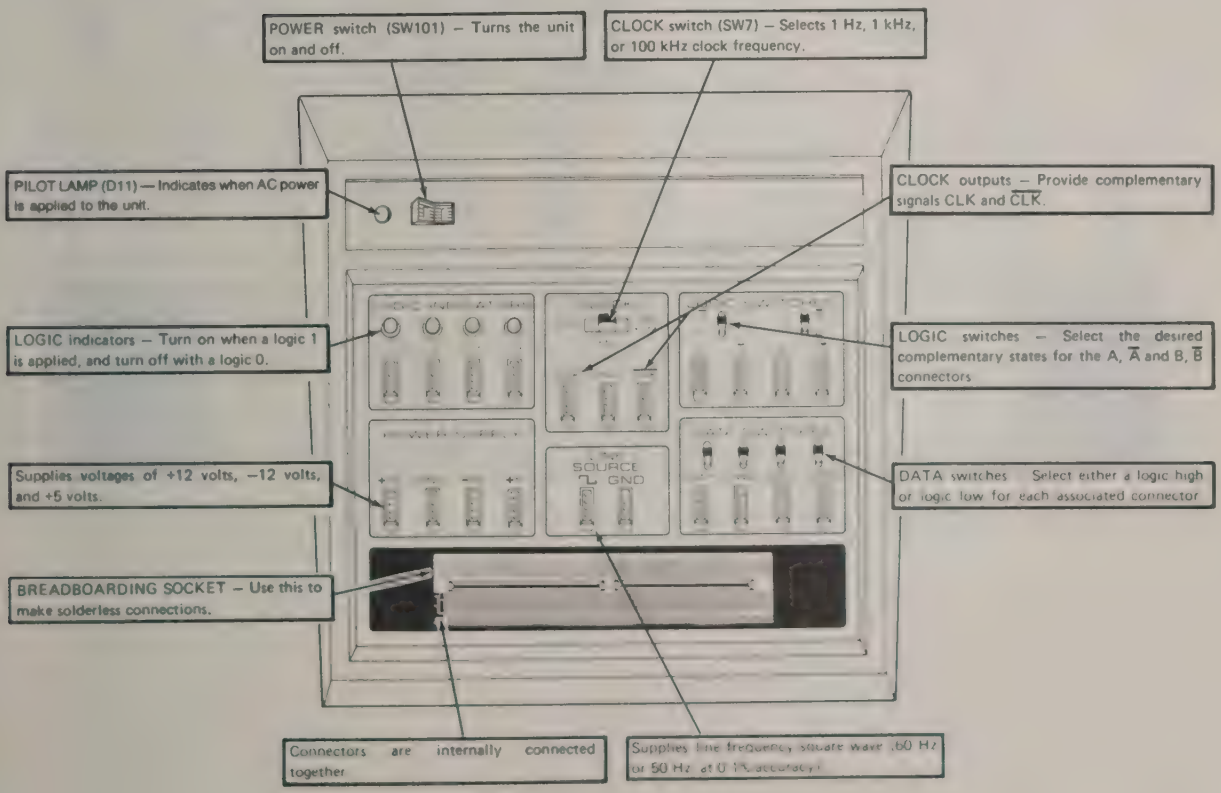
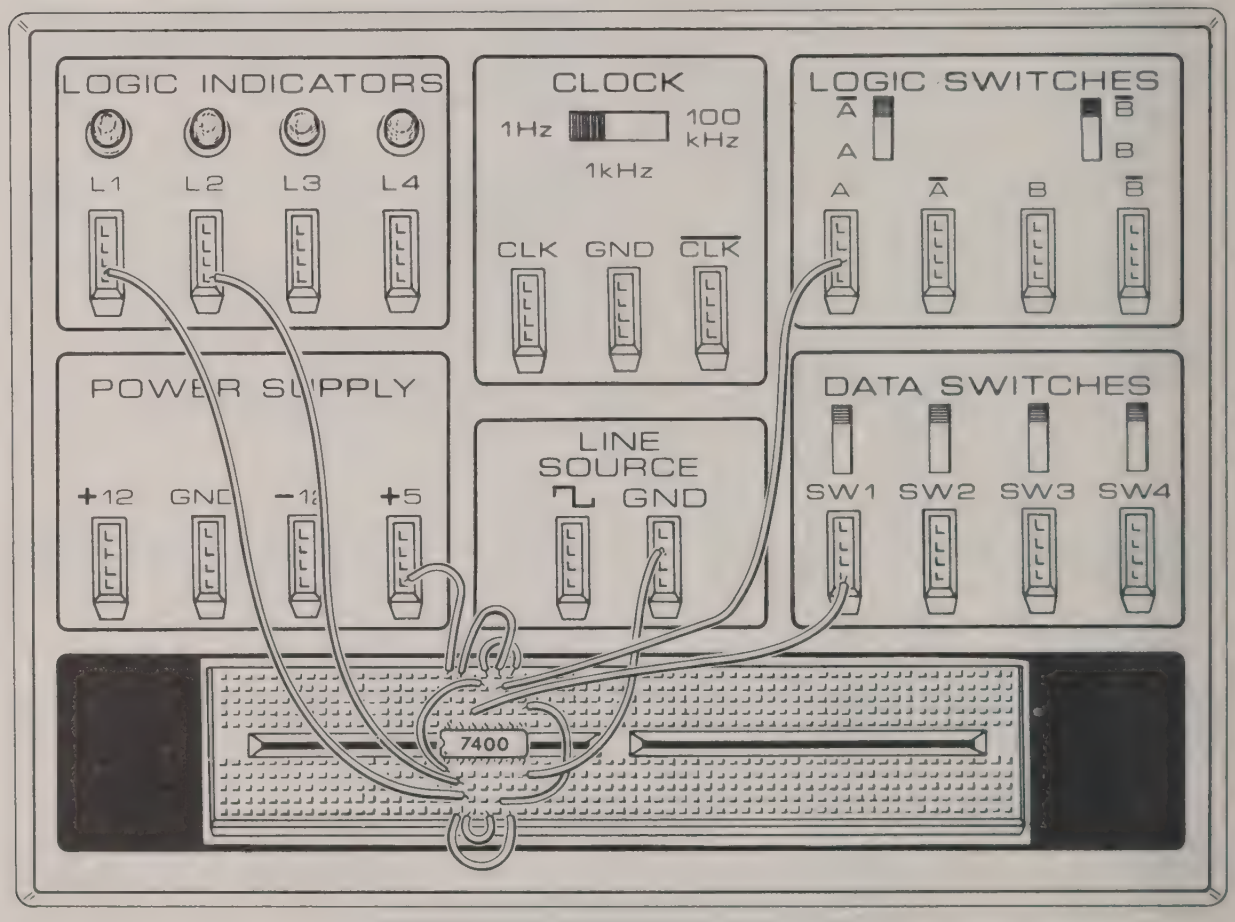
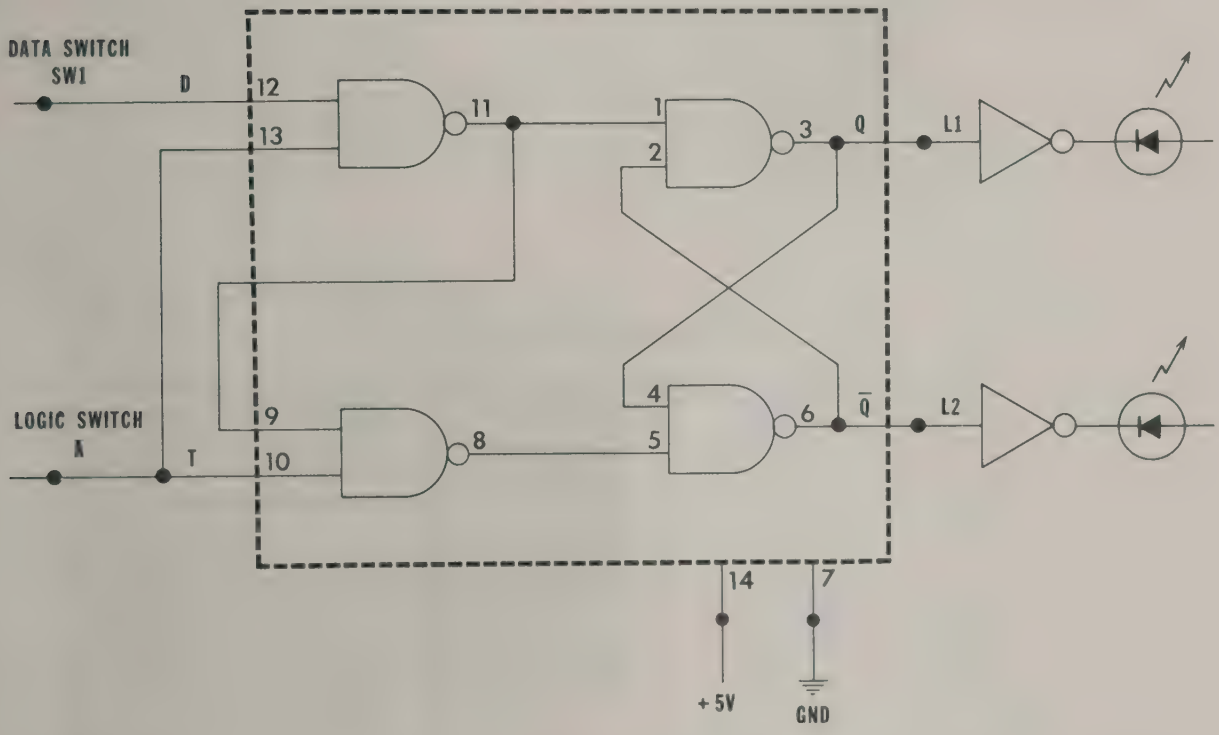

POWER switch (SW101) – Turns the unit on and off.
CLOCK switch (SW7) – Selects 1 Hz, 1 kHz, or 100 kHz clock frequency.
PILOT LAMP (D11) — Indicates when AC power is applied to the unit.
CLOCK outputs – Provide complementary signals CLK and $\overline{CLK}$.
LOGIC indicators – Turn on when a logic 1 is applied, and turn off with a logic 0.
LOGIC switches – Select the desired complementary states for the A, $\overline{A}$ and B, $\overline{B}$ connectors
Supplies voltages of +12 volts, −12 volts, and +5 volts.
DATA switches – Select either a logic high or logic low for each associated connector
BREADBOARDING SOCKET – Use this to make solderless connections.
SOURCE
GND
Connectors are internally connected together
Supplies line frequency square wave (60 Hz or 50 Hz at 0.1% accuracy)

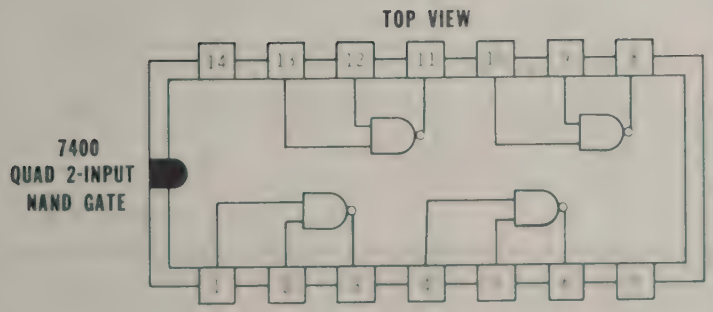
Figure 1

WIRING EXAMPLE



TYPE 7400 QUAD 2-INPUT TTL
NAND GATE CONNECTED AS A
D-TYPE FLIP-FLOP



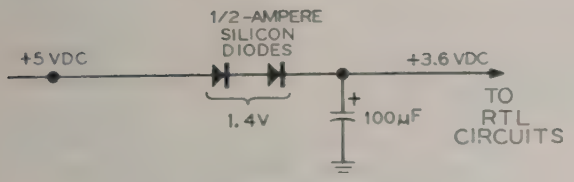


IC Logic Compatiblity

As shown in the following "IC Compatibility Chart," the power supplies and other circuitry of your Digital Experimenter are compatible with most of today's commonly used logic families. Figure 2 (on Page 39) shows how the power supply can be adapted for still another logic family, and Figures 3 and 4 show simple interface (connecting) circuitry between some of these families.

IC COMPATIBILITY CHART

TYPE OF IC	TYPICAL SUPPLY VOLTAGE	COMPATIBLE WITH INDICATOR AND SWITCHES	COMMENTS
RTL	+3.6V (See Note 1 on Page 39)	Yes (See Note 2 on Page 39)	
DTL	+5V	Yes	
TTL	+5V	Yes	Applies to open collector, Schottky, and 3-state types also.
CMOS	+5 +12V	Yes (when used with +5V supply)	Recommend +5VDC for indicator and switch compatibility.
ECL	+5.2V (See Note 3 on Page 39)	No (See Note 4 on Page 39)	Check ECL manufacturer's literature before using.
nMOS	+5V	Yes	Not all nMOS uses a +5 volt supply. Check manufactuer's data.
pMOS (See Note 5)	+5V −12V	Yes	TTL compatible, static types only.
Linear	+12V −12V	Not Applicable.	Good for op amps, line drivers and receivers, and other linear circuits.



RECOMMENDED POWER SUPPLY CIRCUIT FOR RTL IC'S.

Figure 2

NOTES:

1. Use circuit shown in Figure 2 to derive the recommended supply voltage for RTL IC's.

2. Outputs of data and logic switches in the binary 1 state are a higher voltage than that required by RTL circuits. But the higher voltage will not damage RTL circuits and they will operate satisfactorily.

3. The recommended ECL supply voltage is −5.2 VDC. However, by reversing the ground and supply voltage connections, +5 volts from the ET-3200 can be used. Connect the IC ground to +5 volts and the normal supply input (VEE) to ground. This will produce satisfactory operation for most applications.

4 Even with a +5-volt supply on the ECL circuits, this type of IC is not compatible with the switches and indicators on the ET-3200. With some simple circuit additions, you can obtain full compatiblity. Figure 3 shows two simple circuits to convert standard TTL levels to ECL levels. The second circuit in Figure 3 can also be used to convert the clock, data switch, and logic switch outputs of the ET-3200 to ECL levels.

   Figure 4 shows circuits for converting ECL levels to TTL levels. All of these level translator circuits assume that both ECL and TTL circuits will be operating from the same +5-volts supply.

5 Static type only. Dynamic pMOS requires more sophisticated interfacing. In all cases, check the manufacturer's data sheets.

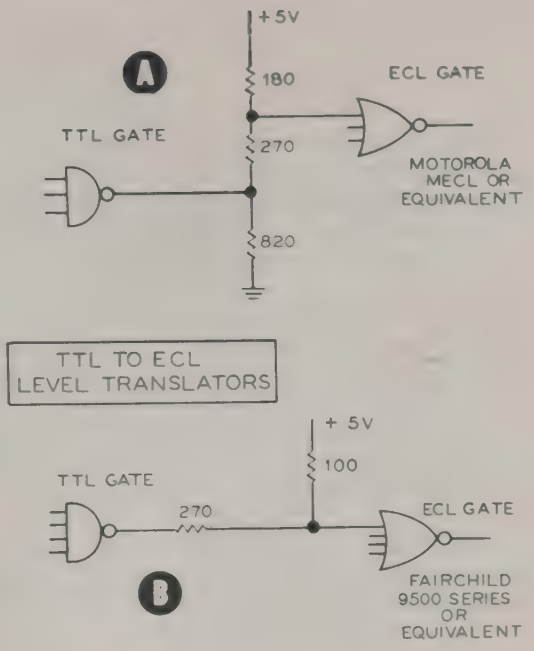


Figure 3

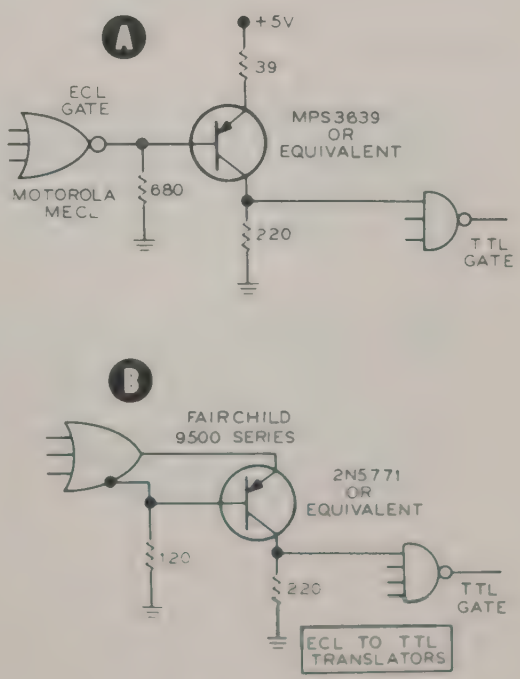


Figure 4

IN CASE OF DIFFICULTY

Use the "Visual Tests" first to find a difficulty that shows up right after your kit is assembled. You can also use the "Troubleshooting Charts" right after your kit is assembled, or at some future time in case your Experimenter should ever malfunction.

If the trouble is still not located after you complete the "Visual Tests," and a voltmeter is available, check voltage readings against those shown on the "Voltage Chart" (in the Illustration Booklet Page 5). Read the "Precautions" on this Page before you make any measurements. NOTE: All voltage readings were taken with a high input impedance voltmeter.

In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

NOTE: Refer to the "Circuit Board X-Ray View" Page 44 for the physical location of parts on the circuit boards.

VISUAL TESTS

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you consistantly overlook.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all connections to make sure they are soldered as described in the "Assembly Notes" on Page 5 and Page 10.

3. Check to be sure that all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check to be sure that each of the IC pins are properly installed in their connectors, and not bent or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 680 Ω (blue-gray-brown) resistor where a 6800 Ω (blue-gray-red) resistor should have been installed.

6. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

7. A review of the "Circuit Description" may also help you determine where the trouble is.

PRECAUTIONS

1. Be cautious when you test IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to damage one or more IC's, transistors, or diodes.

Troubleshooting Chart

PROBLEM	POSSIBLE CAUSE
Pilot lamp does not light.	1. Fuse F101.
+12-volt power supply varies with Voltage Adjust control R6 but will not reach +12 volts DC.	1. Zener diode ZD1.
Both plus and minus 12-volt supplies are high and will not adjust.	1. Transistor Q3 open. 2. Transistor Q1 shorted. 3. Transistor Q2 shorted.
−12-volt supply is high; +12-volt supply is OK.	1. Transistor Q7 open. 2. Transistor Q5 shorted. 3. Transistor Q6 shorted.
LED remains lit with no input.	1. L1: Transistor Q9 or Q10. L2: Transistor Q11 or Q12. L3: Transistor Q13 or Q14. L4: Transistor Q15 or Q16.
Clock will not change frequency.	1. Switch SW7.

SPECIFICATIONS

Power Supplies:

Output Voltages	+12 volts DC at 100 mA. −12 volts DC at 100 mA. +5 volts DC at 500 mA with thermal overload protection.
Load Regulation	+12 volts DC, better than 1%. −12 volts DC, better than 1%. +5 volts DC, better than 2%.

Data Switches:

States	+5 volts or 0 volts.
Maximum Current	10 mA, each switch.
Output	4 terminals, one for each switch.

Logic Switches:

Type	Momentary contact, spring loaded.
Circuit	Two flip-flop latches for contact bounce buffering.
Output States	Complementary, +5 volts and +0.2 volts.

Clock:

Frequency Selection	3-position slide switch.
Output Frequency	1 Hz, 1 kHz, 100 kHz; ±20%.
Duty Cycle	45%.
Output Voltage	5 volts peak-to-peak.
Output Terminals	Normal and complement.
Logic Indicators	Red light emitting diode (LED).

General:

Power Requirements	105-130 volts or 210-260 volts rms, 50-60 Hz, 15 watts maximum.
Fuse	3/16-ampere, slow-blow.
Dimensions	12-1/8" wide × 11-3/4" deep × 3-1/2" high.
Net Weight	4 lbs.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (Illustration Booklet Page 6) while you read this "Circuit Description."

DATA SWITCHES

These switches select either ground potential or +5 volts DC. Resistor R39 limits the current.

LOGIC SWITCHES

Switch A-$\overline{A}$ controls a latching flip-flop made up of sections A and B of IC2. When switch SW5 is in the $\overline{A}$ position, pins 1 and 2 are low. This produces a high at pins 3 and 4. Because pin 5 is floating at this time, it is also considered to be high. This makes a low at pin 6. When SW5 is in the A position, a low is at pin 5. This forces pins 6 and 2 high. With highs at pins 1 and 2, pins 3 and 4 go low and the outputs A and $\overline{A}$ have changed state.

Switch B-$\overline{B}$ operates the same as switch A-$\overline{A}$.

LOGIC INDICATORS

With no input to connector L1, transistors Q9 and Q10, and LED L1 are off. When a high is applied to connector L1, transistor Q9 turns on transistor Q10. Current then flows through LED L1, resistor R23, transistor Q10, and the LED turns on. The other indicators operate in the same manner.

CLOCK

The clock is made up of IC3 (a 555 timer), and the RC time frequency control components. These are R46, R47, and C9, C10, or C11. Switch SW7 selects the desired capacitor. The output of IC3 (pin 3) is applied to two NAND gates that operate as inverters to produce the CLK and $\overline{CLK}$ outputs.

LINE FREQUENCY SIGNAL

The line frequency signal is coupled from the secondary of T101, through resistor R41, to the base of transistor Q17. Diode D9 half-wave rectifies the signal. This leaves the positive excursions to turn on transistor Q17. Transistor Q17 then drives section B of IC4, which is a NAND gate connected as an inverter.

+5-VOLT SUPPLY

The secondary voltage of transformer T101 is rectified by diodes D1 through D4, filtered by capacitor C2, and regulated by IC1.

12-VOLT SUPPLIES

The center-tapped secondary of transformer T101 is rectified by diodes D5 through D8 and filtered by capacitors C1 and C6.

Transistor Q1 is a current amplifier for pass transistor Q2. If the current through Q2 becomes excessive, the voltage developed across R4 turns on transistor Q4. The current that was flowing through R2, R3, and Q1 now has another path, through Q4. Therefore, if Q4 turns on harder, less current flows into the base of Q1 and Q2. This in turn allows less current to flow from the collector to emitter of Q2 and the current is limited to a safe value.

If the output voltage changes, this change is sensed by voltage divider R6 and R7, and is applied to the base of Q3. The base voltage of Q3 therefore changes, but the emitter is held constant by ZD1. This causes the current through Q3 to change and again control Q1 and Q2 as before until the output voltage is at the proper value.

The positive 12-volt supply is used as the reference for the negative 12-volt supply. Voltage divider R17 and R18 monitor the outputs of the supplies and control Q7. The negative supply operates similar to the positive supply.

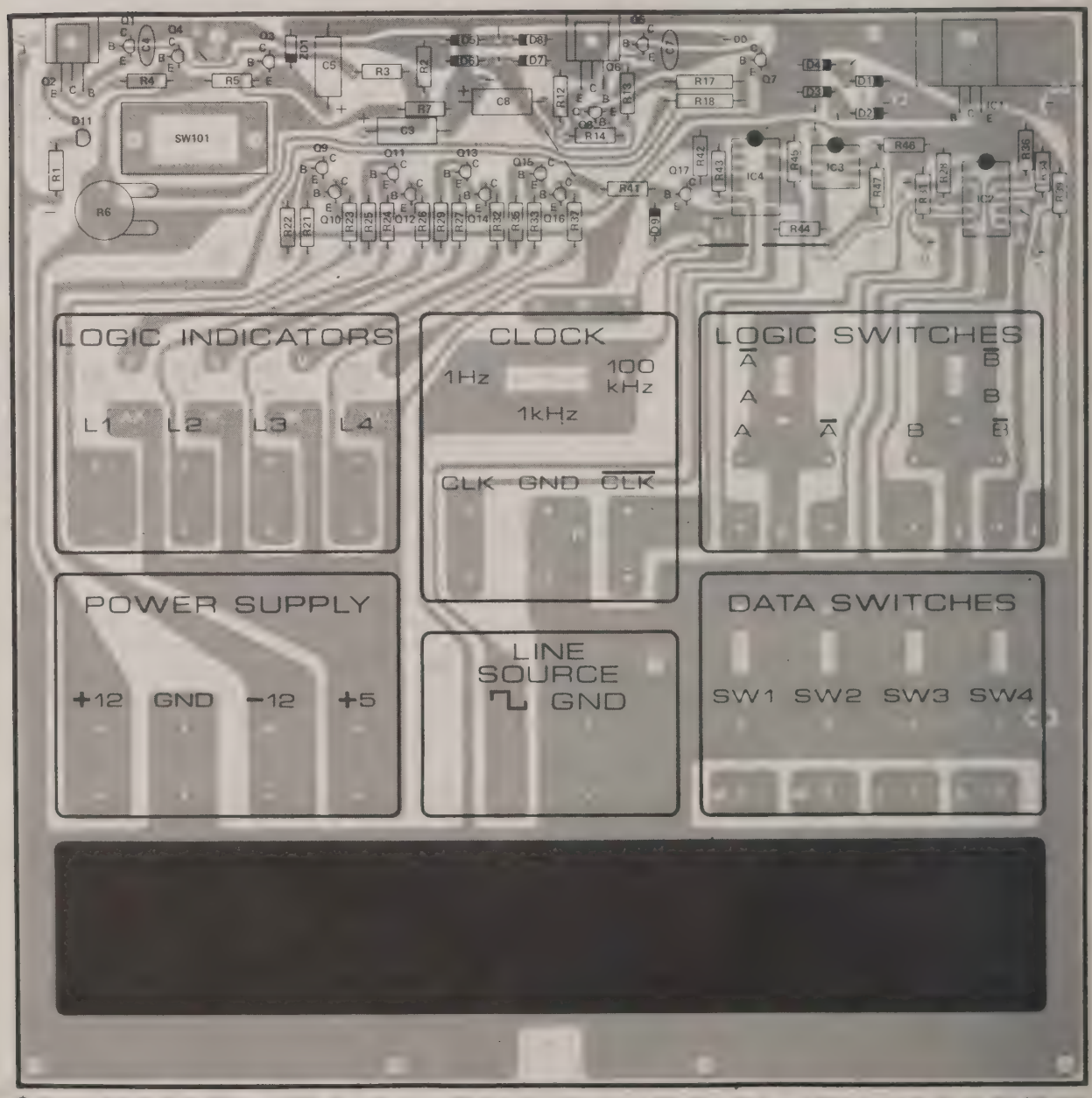
CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."*

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

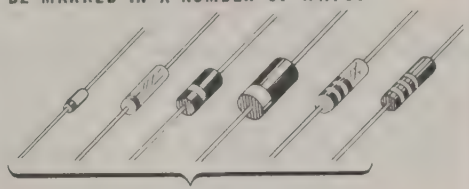
C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



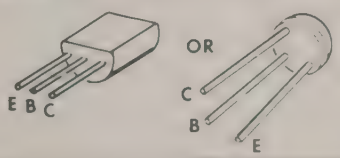
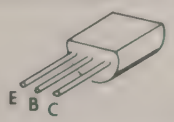
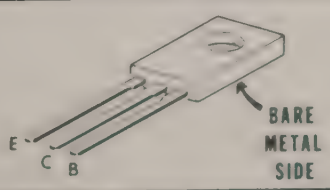
* Resistors R48, R49, R51, and R52, from the base (B) to gnd on transistors Q9, Q11, Q13, and Q15, respectively, on the foil side of the circuit board, are not shown.

IDENTIFICATION CHARTS

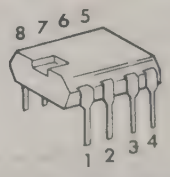
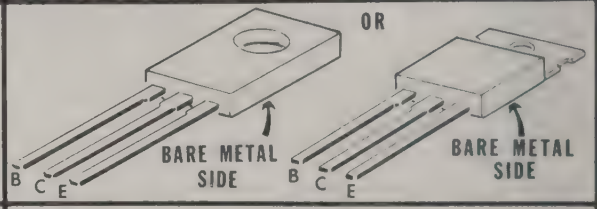
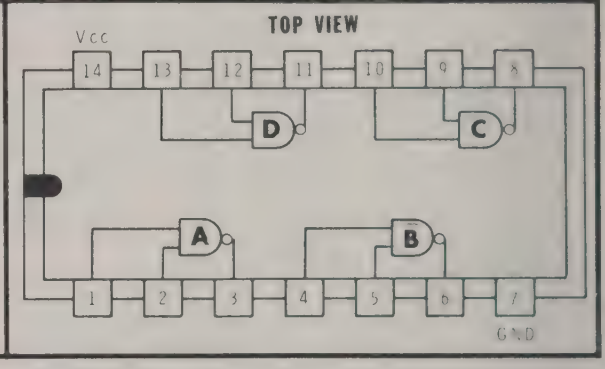
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
D9	56-56	1N4149	IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.  BANDED END
ZD1	56-97	1N3017	
D1, D2, D3, D4, D5, D6, D7, D8	57-65	1N4002	
LED1, LED2, LED3, LED4, D11	412-640		

TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
Q5, Q7, Q8	417-235	2N4121	
Q1, Q3, Q4, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17	417-801	MPSA20	
Q2	417-818	MJE181	
Q6	417-819	MJE171	

INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
IC3	442-53	NE555V	
IC1	442-54	μA7805	
IC2, IC4	443-54	SN7403N	

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath/Zenith Computers and Electronics centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH/ZENITH COMPUTER AND ELECTRONICS CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath/Zenith Computer and Electronics centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath/Zenith Computer and Electronics center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? – Operation? — Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heath/Zenith Computer and Electronics center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heath/Zenith Computers and Electronics center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

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ZENITH

MP MASTER
MA22858

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